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AN ALDEHYDE ROSIN OIL FROM PHILIPPINE PINE TREES (PINUS INSULARIS ENDLICHER)

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The Benguet pine (*Pinus insularis* Endlicher) grows extensively in the mountain regions of northern Luzon. Some months ago the resin content of Benguet pine was investigated [1] and the results showed that it yields turpentine and rosin of high grade. The rosin is obtained in the usual manner by steam distilling the pine resin; the turpentine passes over into the distillate leaving the crude rosin behind.

Experiments [2] have shown that the crude amorphous rosin may be converted by solvents into a crystallized form. When distilled the amorphous rosin is changed into a transparent glassy variety.

Recently we distilled the crude rosin in a current of alcohol. From the distillate we obtained an oil boiling at 80° to 81° C. This oil appears to consist mostly of an aldehyde.

EXPERIMENTAL PROCEDURE

The pine resin used in this investigation was collected by Ranger P. D. Esguerra, of the Philippine Bureau of Forestry. The resin was steam distilled to separate the turpentine, which passed over into the distillate, from the rosin which remained behind as the residue.

[1] Santos, I. de, A. P. West, and J. Fontanoza, Philip. Journ. Sci. 46 (1931) 233, 383.

[2] Tanchico, S. S., A. P. West, and P. D. Esguerra, Philip. Journ. Sci. (in press).

Samples of commercial rosin, as ordinarily prepared, may give melting points that vary considerably. This is due to the fact that commercial rosin often contains varying amounts of oily substances, which are not removed during the steam distillation of the pine resin. The rosin that remains as a residue from steam distillation is not very hard and brittle. In a tropical climate it displays a tendency to soften and gradually flow due to the oil contained in it.

The crude rosin, obtained as a residue in distilling the pine-tree resin, was dissolved in alcohol and filtered to remove impurities such as twigs and chips of wood. The alcoholic solution of rosin was distilled with a current of alcohol vapor running through it. The distillate was found to consist of an alcoholic solution of light rosin oil. This light rosin oil appears to be the substance which causes the characteristic odor of Philippine rosin. The distillation was continued until the distillate, when treated with water, no longer gave a milky solution, thus indicating that most of the light rosin oil was removed from the rosin. To the alcoholic distillate, thus obtained, a considerable quantity of water was added to dissolve the alcohol. This produced a milky solution which was then extracted with ether. The ether extract was dehydrated first with calcium chloride and later with sodium sulphate, after which it was distilled to remove the ether. The residue consisting largely of the light rosin oil was then fractionated. The results are recorded in Table 1.

TABLE 1.—*Distillation of Benguet aldehyde rosin oil.* (*Amount of oil distilled 432 cubic centimeters.*)

Fraction. No.	Fraction. Temperature.	Amount obtained.		Refractive index, $N\frac{30^\circ C.}{D}$	Specific gravity, $d\frac{30^\circ}{4^\circ}C.$	Optical rotation $A\frac{30^\circ C.}{D}$ (100 millimeter tube).
	°C.	g.	Per cent.			Degrees.
	low 79.............cc.	56	....			
	Above 79–80.	108.55	23.96	3665	0.8216	+1.23
	Above 80–82.	92.7	21.46	.3638	0.8279	+0.14
	Above 82–86.	21.0	4.86	3630	0.8403	− 0.2
	Above 86–95.	15.2	3.51	3618	0.8485	− 0.2
	Residue.....	65.9	15.25	3605	0.8793	− 0.2

The first fraction (Table 1) contains alcohol and ether and the residue some high boiling substances. The first fraction and the residue were discarded and the intermediate fractions

(Nos. 2 to 5) redistilled. After fractionating several times a fraction amounting to about 75 cubic centimeters was obtained.

This fraction had a fairly constant boiling point of 80° to 81° C. Other constants of this fraction were as follows:

Specific gravity $\left(d\ \frac{30^\circ}{4^\circ}C.\right)$ 0.8382

Specific rotation $\left(A\ \frac{30^\circ\ C.}{D}\right)$ + 1.32

Refractive index $\left(N\ \frac{30^\circ\ C.}{D}\right)$ 1.3636

This oil gave the usual tests for double bonds such as decolorizing a bromine solution and an alkaline solution of potassium permanganate.

The oil gave very decided tests for aldehydes as follows:

A red color with Schiff's reagent within a time limit of two minutes.
Orange color with a glacial acetic acid solution of benzidine.
Reduced Fehling's solution giving cuprous oxide precipitate.
Gave positive test with Tollen's reagent.

From 12.5 grams of oil there was obtained 9.9 grams of the aldehyde sodium bisulphite compound.

When mixed with water a milky solution is obtained but the oil is soluble in all the common organic solvents.

The yield of this aldehyde oil (80° to 81° C.) from the crude rosin was found to be about 4 per cent.

We expect to continue this investigation when more of this aldehyde oil is available.

We wish to thank Mr. Arthur F. Fischer, director, Bureau of Forestry, and Mr. P. D. Esguerra, Bureau of Forestry, for their assistance in this investigation.

SUMMARY

Rosin was prepared from the resin of Benguet pine trees (*Pinus insularis* Endlicher). This rosin yields a colorless, light, aldehyde rosin oil. The yield is about 4 per cent.

This aldehyde oil boils at from 80° to 81° C. It gives a milky solution with water but is soluble in the common organic solvents.

COMPOSITION OF PHILIPPINE RICE OIL (RAMAI VARIETY)

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and

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As rice is the staple diet of the inhabitants of the Far Eastern countries the rice bran (polishings) naturally accumulates in considerable quantities as a by-product. The bran comprises the seed coat and germ of the rice grain. It is now used for cattle food and to a slight extent for making tikitiki extract, which is employed in treating the disease known as beriberi.

Rice oil occurs in rice bran. Recently we analyzed Philippine rice oil made from bran of the ramai variety of rice. Our results showed that the oil consists principally of glycerides of oleic, linolic, and palmitic acids and is very similar in composition to kapok, cottonseed, and peanut oil. Rice oil has a bland, fatty taste and according to the composition is suitable for various purposes, such as making edible products and soap, for which cottonseed oil may be employed.

Some years ago the attempt was made to produce rice oil commercially but Lewkowitsch [1] states that the venture was not successful due, probably, to the low price of oils and fats which prevailed at that time.

When rice bran is stored the oil in the bran hydrolyzes very rapidly with the production of a considerable quantity of free fatty acids. According to Browne [2] this rapid decomposition of the oil is due to a fat-splitting enzyme. Experiments carried out by Browne indicated that the fat-splitting enzyme contained in the bran could be destroyed by heating the bran to a temperature of about 90° C. To prevent the formation of free acids in rice bran and the resulting rancidity Browne suggested heating the bran, immediately after milling, to a dry heat sufficient to destroy the enzyme, such as is done in the kiln-drying of certain seeds.

[1] Chemical Technology and Analysis of Oils, Fats, and Waxes 2 (1922) 330.

[2] Journ. Am. Chem. Soc. 25 (1903) 948.

Ramai rice is a Philippine lowland variety which requires plenty of water for cultivation. Although it matures slowly it is the highest yielding variety in the Philippines. An account of the cultivation of ramai rice at the Central Luzon Agricultural School is given by Vicente Aragon.[3] At this school and in nearby localities it was found that this variety requires nearly two hundred days to mature. The highest yields are obtained by transplanting the rice. In ordinary irrigated land the yield may be more than 100 cavanes per hectare.

Ramai rice has rather large grains which have an average length of 7.74 millimeters; an average width of 3.47 millimeters; and an average thickness of 2.28 millimeters. As an edible product the ramai rice is not as tasty as some varieties of rice which have smaller grains.

EXPERIMENTAL PROCEDURE

This ramai rice was milled under the supervision of Vicente Aragon, of the College of Agriculture, University of the Philippines. The bran that was sufficiently fine to pass a 40-mesh sieve was extracted for two days with ether. The ether extract was then filtered and the filtrate distilled to remove the ether. The rice oil was then treated successively (warming, shaking, and filtering) with kieselguhr, suchar, and talcum powder. The brilliantly clear oil thus obtained had a rather dark brown color with a greenish tinge. The yield was about 18 per cent calculated on a moisture-free basis. The physical and chemical constants of this ramai variety of rice oil are given in Table 1.

TABLE 1.—*Physical and chemical constants of Philippine rice oil (ramai variety).*

Specific gravity at $\frac{30^\circ}{4^\circ}$ C.	0.9059
Refractive index at 30° C.	1.4662
Iodine number (Hanus)	99.3
Saponification value	185.9
Unsaponifiable matter (per cent)	4.02
Acid value	42.16
Saturated acids, determined (per cent)	20.71
Unsaturated acids plus unsaponifiable matter, determined (per cent)	72.71
Saturated acids, corrected (per cent)	19.95
Unsaturated acids, corrected (per cent)	69.68
Iodine number of unsaturated acids (determined)	124.7

[3] Philip. Agr. 18 (1930) 535.

The saturated and unsaturated acids that occur as glycerides in Philippine rice oil (ramai) were separated by the lead-salt-ether method[4] in accordance with the suggestions of Baughman and Jamieson.[5] The results are recorded in Table 2.

TABLE 2.—*Separation of saturated acids from the unsaturated acids in Philippine rice oil (ramai variety) by the lead-salt-ether method.*

Experiment No.	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids (determined).	Saturated acids (determined).	Unsaturated acids (corrected).[a]	Saturated acids (corrected).
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	9.4675	6.9111	1.9570	73.00	[b]20.67	69.99	19.88
2	9.6694	7.0012	2.0052	72.41	[c]20.74	69.36	20.02
Mean				72.71	20.71	69.68	19.95

[a] Unsaturated acids (with unsaponifiable matter removed); iodine number (Hanus), 124.7.

[b] Iodine number (Hanus), 4.8.

[c] Iodine number (Hanus), 4.8.

The unsaturated acids separated from ramai rice oil by the lead-salt-ether method were treated with bromine and converted into their bromo-derivatives.[6] No ether-insoluble hexabromide was obtained, thus showing the absence of linolenic acid. The composition of the mixed unsaturated acids, which occur as glycerides in ramai rice oil, was calculated from the iodine number of the unsaturated acids. The results are recorded in Table 3. There are also included the calculated percentages of glycerides corresponding to these individual unsaturated acids.

TABLE 3.—*Percentage composition of the unsaturated acids of rice oil (ramai variety) and the glycerides corresponding to these acids.*

Acid.	Mixture of unsaturated acids.	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	37.84	26.37	27.56
Oleic	62.16	43.31	45.26
Total	100.00	69.68	72.82

[4] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.

[5] Cotton Oil Press 6 (1922) 41. Journ. Am. Chem. Soc. 42 (1920) 2398.

[6] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

Saturated acids.—The saturated acids were separated from ramai rice oil by the lead-salt-ether method and esterified with methyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours, after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal solution washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters, which were yellow, were distilled under diminished pressure. A preliminary distillation at about 3.5 millimeters pressure was made. The esters were then redistilled at 5 millimeters pressure. Data on the distillation of the esters are given in Tables 4 and 5.

TABLE 4.—*First distillation of the methyl esters of the saturated acids; pressure, 3.5 millimeters; 111.2771 grams of esters distilled.*

Fraction.	Temperature.	Weight.
	°C.	g.
A	145–164	26.0452
B	164–169	24.1373
C	169–173	23.9360
D	173–180	18.3872
E	180–195	11.2864
F	195–215	3.3484
Residue		2.95
Total		111.0772

TABLE 5.—*Second distillation of the methyl esters of the saturated acids; pressure, 5 millimeters; 111.0772 grams of esters redistilled.*

Fractions.		Temperature.	Weight.
From first distillation.	Second distillation.		
		°C.	g.
A and B	1	175–177	11.3975
C	2	177–181	43.9698
D	3	181–184	29.7490
E and F	4	184–190	7.3525
Residue	5	190–195	5.3610
	6	195–210	5.3322
	7	210–225	4.7912
	Residue.		2.07
Total			111.0542

In Table 6 are given the analyses of fractions obtained in the second distillation of methyl esters. From the data (Table 6) there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 7 and were calculated in accordance with the methods outlined by Baughman and Jamieson in their investigations of Hubbard squash-seed oil [7] and also American cottonseed oil.[8]

TABLE 6.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*[a]

Fraction—	Iodine number.	Saponification value.	Mean molecular weight of mixed esters.	Composition of mixed esters. Saturated.	Composition of mixed esters. Unsaturated.	Mea molecu weight satura ester
				Per cent.	*Per cent.*	
	1 10	208.3	269.3	0.93	99.07	269.1
	1.79	206.3	271.9	1.51	8.49	271.7
3.	3.98	205.2	273.4	3.35	96.65	272.7
4.	7.33	201.4	278.6	6.18	93.82	277.4
5.	11.12	197.7	283.8	9.37	90.63	282.6
	14.15	186.9	300.2	11.92	88.08	300.8
	7 94	159.6	351.5	6.69	93.31	358.7

[a] Calculated iodine number of unsaturated methyl esters was 118.7. Calculated saponification value of unsaturated methyl esters was 190.0.

TABLE 7.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction—	Acid. Myristic.		Palmitic.		Stearic.		Arachidic.		Lignoceric.	
	Per cent.	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*
1	3.99	0.45	89.93	10.25						
2.			88.72	39.01	4.69	2 06				
3.			83 79	24.93	7 89	2.35				
4.			66.40	5.23	22.67	1.79				
			48.19	2 82	37.94	2 22				
					76.45	4.08	7.53	0.40		
							37.73	1.81	51.92	2.49
Residue [a]										1.99
Total		0.45		82.24		12.50		2.21		4.48

[a] Residue assumed to be methyl lignocerate.

[7] Journ. Am. Chem. Soc. 42 (1920) 156. [8] Op. cit. 1197.

In Table 8 is given the composition of the mixed saturated acids and the glycerides in the original sample of ramai rice oil corresponding to these acids.

TABLE 8.—*Saturated acids.*

Acid.	Mixture of saturated acids.[a]			Glycerides in original oil.
	Weight.	Composition.	Proportions in original oil.	
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Myristic	0.45	0.44	0.09	0.10
Palmitic	82.24	80.72	16.10	16.89
Stearic	12.50	12.27	2.45	2.56
Arachidic	2.21	2.17	0.44	0.46
Lignoceric	4.48	4.40	0.87	0.90
Total	101.88	100.00	19.95	20.91

[a] When separated from rice oil the corrected percentage of saturated acids was 19.95.

The composition of ramai rice oil is given in Table 9. There are also included for comparison the analysis of Philippine hambas rice oil and the composition of a sample of rice oil analyzed by G. S. Jamieson.

TABLE 9.—*Composition of rice oil.*

Constituent.	Philippine rice oil (ramai variety).	Philippine rice oil (hambas variety)[a] analyzed by A. O. Cruz and A. P. West.	Rice oil[b] analyzed by G. S. Jamieson.
Glycerides of:	*Per cent.*	*Per cent.*	*Per cent.*
Unsaturated acids—			
Oleic	45.3	45.6	41.0
Linolic	27.6	27.7	36.7
Saturated acids—			
Myristic	0.10	0.2	0.3
Palmitic	16.9	17.3	12.3
Stearic	2.6	1.8	1.8
Arachidic	0.5	0.7	0.5
Lignoceric	0.90	0.7	0.4
Unsaponifiable matter	4.0	4.0	4.6
Total	97.9	98.0	97.6

[a] Philip. Journ. Sci. (in press).

[b] This oil was an ether extract of rice bran made by C. E. F. Gersdorff, of the Bureau of Chemistry, Washington, Journ. Oil and Fat Indus. 3 (1926) 256.

TABLE 10.—*Comparison of Philippine rice oil (ramai) with other oils.*

Constituent.	Philippine oils.			American oils.	
	Philippine rice oil (ramai variety).	Kapok-seed oil.[a]	Peanut oil.[b]	Cotton-seed oil.[c]	Peanut oil.[d]
Glycerides of:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Unsaturated acids—					
Oleic	45.3	49.8	53.9	35.2	52.9
Linolic	27.6	29.3	27.0	41.7	24.7
Saturated acids—					
Myristic	0.10	0.5	....	0.3	....
Palmitic	16.9	15.9	8.5	20.0	8.2
Stearic	2.6	2.3	3.6	2.0	6.2
Arachidic	0.5	0.8	3.4	0.6	4.0
Lignoceric	0.90	....	2.4	....	3.1
Unsaponifiable matter	4.0	0.8	0.3	....	0.2
Total	97.9	99.4	99.1	99.8	99.3

[a] Philippine kapok-seed oil (*Ceiba pentandra* Gaertner) analyzed by A. O. Cruz and A. P. West, Philip. Journ. Sci. 46 (1931) 131.

[b] Philippine peanut oil (Valencia variety) analyzed by A. O. Cruz and A. P. West, Philip. Journ Sci. 46 (1931) 199.

[c] American cottonseed oil analyzed by G. S. Jamieson and W. F. Baughman, Journ. Am. Chem. Soc. 42 (1920) 1197.

[d] American peanut oil (Spanish type) analyzed by G. S. Jamieson, W. F. Baughman, and D. Brauns, Journ. Am. Chem. Soc. 43 (1921) 1372.

In Table 10 is given the composition of Philippine rice oil (ramai) compared with other Philippine and American oils. As shown by the data the rice oil is very similar in composition to kapok, cottonseed, and peanut oils. All of these oils consist principally of glycerides of oleic, linolic, and palmitic acids. They are suitable commercially for the various purposes for which cottonseed oil is employed; that is, the high-grade oils are useful for making edible products while the lower grades may be employed in soap making.

The commercial possibilities of rice oil would depend upon the current price and available supply of other oils; such as, coconut, cottonseed, etc. In case of a scarcity of these other oils the rice oil may become a commercial product of considerable importance.

A serious drawback to the commercial development of the rice-oil industry is that the oil is not easily expressed from the bran. Recently, we tried to express the oil from rice bran by using a hydraulic press of the coconut-oil mill of the Spencer,

Kellogg Company. With a pressure of 4,000 pounds, which is commonly employed for expressing coconut oil, practically no oil was obtained from rice bran. To produce rice oil commercially it would seem that an extraction plant would be necessary.

We wish to thank Mr. H. Hellis, of the Spencer, Kellogg Company, who very kindly permitted us to use a hydraulic press.

SUMMARY

Rice oil is obtained from rice bran which comprises the seed coat and germ of the rice grain.

In this investigation we determined the composition of rice oil obtained from bran of the ramai variety of rice. Our results showed that this kind of rice oil consists principally of glycerides of oleic, linolic, and palmitic acids. Ramai rice oil is very similar in composition to kapok, cottonseed, and peanut oils. These oils are suitable commercially for the manufacture of edible products and soaps and for other purposes for which cottonseed oil may be employed.

To produce rice oil commercially it would seem that an extraction plant would be necessary.

Rice oil may be an additional source of income for the rice industry.

COMPOSITION OF PHILIPPINE TALISAY OIL FROM THE SEEDS OF TERMINALIA CATAPPA LINNÆUS

By AURELIO O. CRUZ and AUGUSTUS P. WEST

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The seeds of the plant known botanically as *Terminalia catappa* Linnæus have a kernel which is edible. The kernel yields an oil known locally as talisay oil. Recently we determined the composition of this oil and the results showed that it consists principally of glycerides of oleic, linolic, and palmitic acids. The oil is very similar in composition to kapok, cottonseed, and peanut oils and may be used for the same purposes for which cottonseed oil is employed—that is, the manufacture of edible fats, soaps, and other products.

In India, talisay oil is called Indian almond oil because it resembles oil of sweet almonds. Concerning Indian almond oil Watt[1] gives the following account:

> The kernels yield a valuable oil, similar to almond oil in flavour, odour, and specific gravity, but a little more deeply coloured; it deposits stearine on keeping. It possesses the advantage of not becoming rancid so readily as true almond oil, and if it could be produced cheaply would doubtless compete successfully with it. As the tree is abundant everywhere and the fruit could be doubtless obtained very cheaply, "Indian almond oil" appears to merit the attention of dealers. It was first brought prominently to notice by a Mr. A. T. Smith of Jessor, who in 1843 wrote to the Agr.-Horticultural Society of India an account of its properties and method of preparation. Oil, made experimentally by him, was expressed in the common native mill—a sort of pestle and mortar—from some fruit gathered during a few mornings from under the trees in the neighborhood. After a sufficient quantity had been gathered and allowed to dry in the sun for a few days, which facilitates breaking the nut, four coolies were set to work with small hammers, to separate the kernels from their shells. In four days they broke sufficient quantity for one mill, viz., 6 seers. This quantity put into the mill produced in three hours about 3 pucka seers of oil. Mr. Smith remarks that the actual pressing of the oil is of no consideration, since the value of the oil-cake, to feed pigs, etc., is sufficient to cover the expense, but the breaking of the nuts is a tedious and costly operation, and is a consideration requiring particular attention, with a view to its reduction, if manufacture of the oil on an extensive scale should be attempted. The product of the experiment, filtered through blotting paper, was of the colour of pale sherry, a circumstance which Mr. Smith explains is due to the rind being allowed to remain on the kernels. He concludes by remarking on the ornamental

[1] A Dictionary of the Economic Products of India pt. 4, 6 (1893) 23.

nature and utility of the tree for many other purposes, and recommends that it should be more extensively planted. A sample of the oil thus prepared was submitted for examination to Doctor Mouat, who reported as follows:—"I have compared the specimen with a good muster of the ordinary European almond oil in my possession, and find that in taste, smell, and specific gravity, the former is very similar to the latter, but is deeper in colour, becomes turbid in keeping, and deposits a quantity of white stearic matter. For most ordinary purposes, medicinal and otherwise, the former, I think, might profitably be substituted for the latter in this country, and, if expressed with greater care and freed from every impurity, might become an article of commercial value and importance" (Journ. Agr.-Hort. Soc. Ind., ii.). Though easily made edible and pleasant in flavour, it appears to have been entirely neglected by the Natives, who are ignorant as to its existence.

Terminalia catappa is a tree which reaches a height of 25 meters. In the Philippines this species usually grows near the seashore and is distributed from northern Luzon to southern Mindanao. It is cultivated to some extent as a shade tree in and about Manila and many provincial towns.

EXPERIMENTAL PROCEDURE

The Philippine talisay seeds used in this investigation were kindly given us by Dr. Manuel Roxas, director of the Bureau of Plant Industry. The seeds were broken open and the kernels removed and ground in a mill. The pulp was then extracted with ether to obtain the talisay oil. The oil was purified by treating successively with 2 per cent kieselguhr, suchar, and talcum powder. This treatment removes vegetable fibers and colloidal matter and produces a clear oil which is slightly yellow. The yield of oil obtained from the kernel was about 52 per cent. Calculated on the weight of the whole seed the yield was only about 3 per cent.

The constants of this sample of talisay oil are given in Table 1.

TABLE 1.—*Physical and chemical constants of Philippine talisay oil.*

Specific gravity at $\frac{30^\circ}{4^\circ}$ C.	0.9046
Refractive index at 30° C.	1.4644
Iodine number (Hanus)	75.4
Saponification value	193.2
Unsaponifiable matter (per cent)	0.54
Acid value	2.5
Saturated acids, determined (per cent)	34.82
Unsaturated acids plus unsaponifiable matter, determined (per cent)	59.36
Saturated acids, corrected (per cent)	32.62
Unsaturated acids, corrected (per cent)	61.01
Iodine number of unsaturated acids	122.9

The saturated and unsaturated acids that occur as glycerides in Philippine talisay oil were separated by the lead-salt-ether method [2] in accordance with the suggestions of Baughman and Jamieson.[3] The results are recorded in Table 2.

TABLE 2.—*Separation of saturated acids from the unsaturated acids of talisay oil by the lead-salt-ether method.*

Experiment No.—	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids (determined).	Saturated acids (determined).	Unsaturated acids (corrected).[a]	Saturated acids (corrected).
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	10 0199	5.9897	3.4919	59.28	[b] 34.85	60.98	32.61
2	10.6200	6.3114	3.6941	59.43	[c] 34.78	61.04	32.63
Mean				59.36	34.82	61.01	32.62

[a] Unsaturated acids (unsaponifiable matter removed) ; iodine number (Hanus), 122.9.
[b] Iodine number (Hanus), 7.9.
[c] Iodine number (Hanus), 7.6.

The unsaturated acids separated from talisay oil by the lead-salt-ether method were treated with bromine and converted into their bromo-derivatives.[4] No ether-insoluble hexabromide was obtained, thus showing the absence of linolenic acid. The composition of the mixed unsaturated acids, which occur as glycerides in talisay oil was calculated from the iodine number of the unsaturated acids. The results are recorded in Table 3. There are also included the calculated percentages of glycerides corresponding to these individual unsaturated acids.

TABLE 3.—*Composition of the unsaturated acids of talisay oil and the glycerides corresponding to these acids.*

Acid.	Mixture of unsaturated acids.	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	35.93	21.92	22.91
Oleic	64.07	39.09	40.85
Total	100.00	61.01	63.76

Saturated acids.—The saturated acids were separated from talisay oil by the lead-salt-ether method and esterified with me-

[2] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.

[3] Cotton Oil Press 6 (1922) 41. Journ. Chem. Soc. 42 (1920) 2398.

[4] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

thyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal solution washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters which were yellow, were distilled under diminished pressure. A preliminary distillation at about 4 millimeters pressure was made. The esters were then redistilled at 4 millimeters pressure. Data on the distillation of the esters are given in Tables 4 and 5.

TABLE 4.—*First distillation of the methyl esters of the saturated acids; pressure, 4 millimeters; 123.2236 grams of esters distilled.*

Fraction—	Temperature.	Weight.
	°C.	g.
A	165–178	19.4998
B	178–180	44.6762
C	180–182	22.1372
D	182–187	17.3757
E	187–208	16.6851
Residue		2.68
Total		123.0540

TABLE 5.—*Second distillation of the methyl esters of the saturated acids; pressure, 4 millimeters; 123.0540 grams of esters redistilled.*

Fractions. From first distillation.	Fractions. Second distillation.	Temperature.	Weight.
		°C.	g.
A and B	1	165–178	18.8711
C	2	178–176	35.4190
D	3	176–178	27.9824
E	4	178–181	16.7412
Residue	5	181–187	18.8065
	6	187–192	7.4070
	7	192–214	5.6961
	Residue		2.07
Total			122.9952

In Table 6, are given the analyses of fractions obtained in the second distillation of methyl esters. From the data (Table

6), there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 7 and were calculated in accordance with the methods outlined by Baughman and Jamieson in their investigations of Hubbard squash-seed oil[5] and also American cottonseed oil.[6]

TABLE 6.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*[a]

Fraction—	Iodine number.	Saponification value.	Mean molecular weight of mixed esters.	Composition of mixed esters. Saturated.	Composition of mixed esters. Unsaturated.	Mean molecular weight of saturated esters.
				Per cent.	*Per cent.*	
1	5.0	208.9	268.5	95.73	4.27	267.4
2	6.4	207.6	270.2	94.53	5.47	268.9
3	11.5	205.6	272.9	90.18	9.82	270.6
4	22.2	201.5	278.4	81.04	18.96	274.7
5	35.0	198.1	283.2	70.11	29.89	278.4
6	48.4	190.2	295.0	58.67	41.33	294.6
7	44.1	188.1	298.2	62.34	37.66	300.2

[a] Calculated iodine number of unsaturated methyl esters was 117.1. Calculated saponification value of unsaturated methyl esters was 190.0.

TABLE 7.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction—	Acid. Myristic.		Palmitic.		Stearic.		Arachidic.	
	Per cent.	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*
1	9.31	1.29	81.40	11.29				
2	4.44	1.57	85.17	30.17				
3			84.60	23.67	0.91	0.25		
4			67.77	10.84	12.18	2.03		
5			47.26	6.52	19.33	2.67		
6			7.35	0.54	48.53	3.59		
7					55.33	3.16	4.05	0.23
Residue[a]								1.98
Total		2.86		83.03		11.70		2.21

[a] Residue assumed to be methyl arachidate.

In Table 8 is given the composition of the mixed saturated acids and the glycerides in the original sample of talisay oil corresponding to these acids.

[5] Journn. Am. Chem. Soc. 42 (1920) 156. [6] Op. cit. 1197.

TABLE 8.—*Saturated acids.*

Acid.	Mixture of saturated acids. Weight.	Composition.	Proportions in original oil.	Glycerides in original oil.
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Myristic	2.86	2.87	0.94	1.
Palmitic	83.03	83.20	27.14	28.
Stearic	11.70	11.72	3.82	3.
Arachidic	2.21	2.21	0.72	0.
Total	99.80	100.00	32.62	34.21

In Table 9 is given the composition of Philippine talisay oil compared with other Philippine and American oils. As shown by the data the talisay oil is very similar in composition to kapok, cottonseed, and peanut oils. All of these oils consist principally of glycerides of oleic, linolic, and palmitic acids. They are suitable commercially for the various purposes for which cottonseed oil is employed; that is, the high-grade oils are useful for making edible products while the lower grades may be employed in soap making.

TABLE 9.—*Comparison of Philippine talisay oil with other oils.*

Constituent.	Philippine oils. Talisay oil.	Rice oil (hambas).[a]	Kapok oil.[b]	Peanut oil.[c]	American oil. Cottonseed oil.[d]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Glycerides of:					
Unsaturated acids—					
Oleic	40.85	45.6	49.8	53.9	35.2
Linolic	22.91	27.7	29.3	27.0	41.7
Saturated acids—					
Myristic	1.00	0.2	0.5		0.3
Palmitic	28.47	17.3	15.9	8.5	20.0
Stearic	3.99	1.8	2.3	3.6	2.0
Arachidic	0.75	0.7	0.8	3.4	0.6
Lignoceric		0.7		2.4	
Unsaponifiable matter	0.54	4.0	0.3	0.3	
Total	98.51	98.0	99.4	99.1	99.8

[a] Philippine rice oil (hambas variety). A. O. Cruz, A. P. West, and N. B. Mendiola, Philip. Journ. Sci. (in press).

[b] Philippine kapok oil (*Ceiba pentandra* Gaertner). A. O. Cruz and A. P. West, Philip. Journ. Sci. 46 (1931) 131.

[c] Philippine peanut oil (Valencia variety). A. O. Cruz and A. P. West, Philip. Journ. Sci. 46 (1931) 199.

[d] American cottonseed oil. G. S. Jamieson and W. F. Baughman, Journ. Am. Chem. Soc. 42 (1920) 1197.

SUMMARY

Terminalia catappa is a tree that reaches a height of 25 meters. In the Philippines this species usually grows near the seashore and is distributed from northern Luzon to southern Mindanao. It is sometimes cultivated as a shade tree.

The seeds of *Terminalia catappa* have a kernel which is edible. The kernel yields an oil known locally as talisay oil but in India it is called Indian almond oil.

Talisay oil consists principally of the glycerides of oleic, linolic, and palmitic acids and is similar in composition to kapok, cottonseed, and peanut oils.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), XIV[1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

THREE PLATES

The crane flies described in this report are all from Mindanao, where they were taken in Surigao Province by Mr. A. C. Duyag, and in Davao district by Mr. C. F. Clagg. The collections made by Mr. Duyag are rich in species that were not found by Mr. Clagg in his intensive collecting in the La Lun Mountains and on Mount Apo. I am very greatly indebted to the collectors, and to Mr. Richard C. McGregor, for the continued interest in making known the rich tipulid fauna of the Philippines. The types are preserved in my collection.

TIPULINÆ

DOLICHOPEZA (NESOPEZA) ABDITA sp. nov. Plate 1, fig. 1; Plate 2, fig. 23.

General coloration dark brown; antennæ black, the basal portion of the first segment obscure yellow; legs dark brown, the outer tarsal segments white; wings with a strong blackish suffusion; Rs long; cell 2d A wide.

Male.—Length, about 10 millimeters; wing, 12.

Frontal prolongation of head obscure yellow; palpi black. Antennæ of moderate length, if bent backward extending about to base of abdomen; basal portion of scape yellow, the remainder of antennæ black; flagellar segments subcylindrical, with numerous coarse verticils. Head brown; anterior vertex broad.

Mesonotum chiefly brown, the præscutum indistinctly striped with darker, including a narrow median vitta that is bordered on either side by reddish; posterior sclerites of mesonotum dark brown, sparsely pruinose. Pleura obscure brownish yellow. Halteres elongate, dusky. Legs with the coxæ and trochanters obscure yellow; femora, tibiæ, and proximal ends of basitarsi dark brown, the remainder of tarsi white; on posterior tarsi,

[1] Contribution from the entomological laboratory, Massachusetts State College.

the entire segment is whitened. Wings (Plate 1, fig. 1) with a strong dusky tinge, cells C and Sc, together with a seam along Cu, somewhat darker brown; stigma brown; small whitish obliterative areas before the stigma and across the basal section of M_{1+2}; veins dark brown. Venation: Rs long, exceeding R_{2+3}; forks of medial field relatively short; cell 2d A wide.

Abdominal tergites and hypopygium brownish black, the sternites brownish yellow. Male hypopygium (Plate 2, fig. 23) with the caudal margin of tergite, *9t*, transverse, with small obtuse lateral teeth and more acute submedian denticles. Outer dististyle, *od*, a broad flattened lobe, the apex subtruncate. Inner dististyle, *id*, very broad, produced into a slender apical beak, the margins heavily blackened.

MINDANAO, Davao district, Mount Apo, Baroring River, altitude 7,000 feet, November 9, 1930 (*Clagg*); holotype, male; allotype, female.

Because of the unusual length of Rs, the present species disagrees with all similar forms in the Philippine fauna. By my key to the species of this region,[2] the fly runs out at couplet 5, disagreeing with both included groups in the elongate Rs, in conjunction with the unmarked wings. In this fauna, it is closest to *haightensis* Alexander (couplet 13) in the wide cell 2d A and the distribution of white color on the legs, being well distinguished by the darkened wings, elongate Rs, and structure of the male hypopygium.

DOLICHOPEZA (NESOPEZA) INORNATIPES sp. nov. Plate 1, fig. 2; Plate 2, fig. 24.

Belongs to the *cuneata* group, *cinctitarsis* subgroup; mesonotum light brown to yellowish brown; legs black, the usual white areas much reduced in amount to almost obliterated; abdomen bicolorous; male hypopygium with the elongate tergite profoundly bifid, the mesal-apical angle of each lobe further produced into a glabrous straplike appendage.

Male.—Length, about 10 to 11 millimeters; wing, 10 to 11.

Female.—Length, about 11.5 to 12 millimeters; wing, 12 to 13.

Frontal prolongation of head yellow; basal segment of palpi pale, the remainder dark brown. Antennæ with the scape and pedicel brown, the flagellum black; flagellar segments black, with short verticils; antennæ (male) relatively long, if bent backward extending to the wing root or shortly beyond. Head light brown.

[2] Philip. Journ. Sci. 47 (1932) 169.

Mesonotum light brown to yellowish brown, the præscutum with a narrow darker median vitta. Pleura light yellowish brown to yellow. Halteres dark brown. Legs with the coxæ, trochanters, and narrow femoral bases obscure yellow; remainder of legs black, almost unvariegated, there being only a small amount of white on extreme base of tibia, and more obscurely on the outer tarsal segments; posterior legs with the proximal ends of basitarsi restrictedly dirty white. A few specimens of the large series show an increased amount of white on the legs. Wings (Plate 1, fig. 2) with a brownish tinge, cell Sc and the oval stigma darker brown; in cases, a narrow darkened seam on anterior cord; veins dark brown. Venation: As in the *cuneata* group, cell 2d A very narrow.

Abdomen bicolorous, the segments black at the incisures, obscure yellow medially, the dark color involving both the base and apex of the individual segments. Male hypopygium (Plate 2, fig. 24) with the tergite, *9t*, long and narrow, highly arched as in the subgroup, with a deep median incision; mesal-apical angle of each lobe further produced into a slenderer, entirely glabrous, straplike portion; a narrow, elevated, blackened ridge, or carina, on ventral face near base of each tergal lobe. Ninth sternite, *9s*, broad, the caudal margin broadly and evenly emarginate.

MINDANAO, Davao district, Mount Apo (*Clagg*); holotype, male; allotype, female, altitude 7,000 feet; November 8, 1930; paratypes, 20 of both sexes, altitude 6,000 to 7,000 feet, November 8 to 10, 1930.

By my key to the Philippine species of *Dolichopeza*,[3] the present species runs to *annulitarsis* Alexander (Luzon), differing in the longer antennæ, almost uniformly blackened legs, and the more-elongate glabrous appendage on each lobe of the tergite. The amount of white on the legs is here more reduced than in any other Philippine species of the subgenus *Nesopeza*.

DOLICHOPEZA (NESOPEZA) BICORNIGERA sp. nov. Plate 2, fig. 25.

Belongs to the *cuneata* group and subgroup; male hypopygium with the lateral angles prolonged into flattened acute horns, the median region emarginate, unarmed.

Male.—Length, about 11 to 11.5 millimeters; wing, 12 to 13.

Female.—Length, 12 to 13 millimeters; wing, about 12 to 12.5.

Frontal prolongation of head brown; palpi dark brown. Antennæ (male) dark brown, the basal two segments paler; rela-

[3] Loc. cit.

tively elongate, if bent backward extending to some distance beyond the wing root; verticils numerous but short. Head brown, paler in front.

Mesonotum relatively dark brown, almost unvariegated. Pleura testaceous yellow. Halteres elongate, dark brown. Legs with the coxæ and trochanters testaceous yellow; femora black; tibiæ black, the extreme base whitened; tarsi white, the central portion of basitarsi extensively blackened. Wings as in the *cuneata* group; stigma dark brown; a narrow and vague brown cloud on anterior cord; veins brown. Venation as in the group.

Abdomen bicolorous, the incisures blackened, the central portion of the individual segments more yellowish; outer segments more uniformly blackened; hypopygium obscure yellow. Male hypopygium (Plate 2, fig. 25) with the tergite, *9t*, produced into conspicuous lateral flattened horns, their tips acute; median region of tergite pale, emarginate, provided with abundant yellow setæ but otherwise unarmed. Ninth sternite, *9s*, with the apex weakly emarginate, the median area membranous, the lobes densely provided with setæ, those along margin at apex short and spinose, those of the lobes very long and slender, more or less decussate across the median area.

MINDANAO, Davao district, Mount Apo, Sibulan River, altitude 2,000 feet, October 8, 1930 (*Clagg*); holotype, male; allotype, female; paratypes, 18 of both sexes.

Dolichopeza (Nesopeza) bicornigera is very different from all other described species in the peculiar structure of the male hypopygium, especially of the ninth tergite. By my key to the Philippine species of this genus,[4] the species runs out at couplet 17 by this same peculiarity of structure. This fly will presumably be found to be a low-altitude species in the mountains of the western shore of Davao Gulf.

DOLICHOPEZA (NESOPEZA) RIDIBUNDA sp. nov. Plate 2, fig. 26.

Belongs to the *cuneata* group and subgroup; mesonotum brown, without distinct markings; legs black, the tarsi conspicuously variegated with snowy white; male hypopygium with the tergite acutely toothed; ninth sternite with a deep V-shaped median notch.

Male.—Length, about 10 millimeters; wing, 11 to 11.5.

Female.—Length, about 12.5 millimeters; wing, 13.

[4] Loc. cit.

Frontal prolongation of head brownish yellow, darker brown medially; palpi brownish black. Antennæ with the scape and pedicel light brown, the flagellum darker; antennæ (male) relatively long, if bent backward extending approximately to root of halteres; flagellar segments elongate, with short verticils; terminal segment very small. Head brown.

Mesonotum brown, without distinct markings. Pleura brownish yellow dorsally, more testaceous yellow on ventral portion. Halteres black. Legs with the coxæ and trochanters brownish yellow to yellow; femora yellow basally, passing into dark brown; tibiæ brownish black, the extreme base whitened; basitarsi mostly blackened, with about the proximal and apical fifth or sixth snowy white; remainder of tarsi white, the outer segments a trifle darkened. Wings with a faint brownish tinge, cell Sc a little darkened; stigma oval, dark brown; vague indications of a narrow brown seam on anterior cord; veins dark brown. Venation as in the group.

Abdomen ringed with black and obscure yellow, the latter color occupying the central portion of the individual segments, the dark becoming more extensive on the outer segments; hypopygium chiefly obscure yellow. Male hypopygium (Plate 2, fig. 26) with the tergite, *9t*, relatively small, the caudal margin acutely toothed; lateral tooth slender, acute, glabrous, separated by a narrow U-shaped notch from a median plate that bears smaller acute lateral teeth and a small median denticle that is formed by the outward production of a ventral carina; surface of median plate and disk of tergite with abundant setæ. Caudal margin of ninth sternite, *9s*, with a deep V-shaped median notch, the base of which is filled with membrane, the lobes obtusely rounded and provided with long delicate setæ.

MINDANAO, Davao district, Mount Apo, Baroring River, altitude 7,000 feet, November 9, 1930 (*Clagg*); holotype, male; allotype, female; paratype, male.

By my key to the Philippine species of *Dolichopeza*,[5] the present species runs out at couplet 18, disagreeing with both included species, *angustaxillaris* Alexander (Luzon) and *bagobo* Alexander (Mindanao), by the acute toothing of the ninth tergite and the deep median splitting of the ninth sternite. The nature of the toothing of the tergite is rather more like that of the Bornean *cuneata* Edwards, but still quite different.

[5] Loc. cit.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) MONILIS sp. nov. Plate 1, fig. 3.

Male.—Length, about 5 millimeters; wing, 6; antenna, about 2.3.

Closely allied to *Limonia* (*Limonia*) *multinodulosa* Alexander (Luzon), differing chiefly in the structure and coloration of the antennæ.

Antennæ slightly more elongate than in *multinodulosa,* the individual segments more elongate, especially the terminal segment; basal enlargement of segments black, the apical pedicels abruptly pure white, with only the extreme apex blackened; in *multinodulosa,* the base and pedicel of all segments are uniformly dark brown. Mesonotal præscutum without indications of lateral dark stripes. Wings (Plate 1, fig. 3) with Rs and R_{2+3} more elongate; distal section of M_{1+2} sinuous. Abdomen dark brown, the sternites paler. Male hypopygium very much as in *multinodulosa.*

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, January 1, 1931 (*Clagg*); holotype, male.

LIMONIA (LIMONIA) THETICA sp. nov. Plate 1, fig. 4; Plate 2, fig. 27.

General coloration of mesonotum reddish brown; pleura yellow, with a broad black dorsal stripe; antennæ relatively short, the flagellar segments without pedicels; legs brown, the tarsi and broad tips of all tibiæ white; wings with a brown tinge, the oval stigma darker brown; Sc_1 ending about opposite two-thirds the length of Rs; male hypopygium with the basistyle slender, the lobe basal in position.

Male.—Length, about 3.3 millimeters; wing, 3.5.

Rostrum and palpi black. Antennæ black throughout; relatively short, the flagellar segments oval, with truncated ends but no pedicels; terminal segment a little longer than the penultimate, narrowed at apex. Head dark gray.

Mesonotal præscutum reddish brown, the posterior sclerites, including the median region of scutum and the scutellum, darker brown. Pleura yellow ventrally, the dorsal portion chiefly covered by a blackish longitudinal stripe, broadest anteriorly, narrower behind, passing beneath the root of the halteres to the abdomen. Halteres with blackened knobs, the stem somewhat paler. Legs with the fore coxæ darkened, remaining coxæ and all trochanters yellow; femora yellow basally, passing

to brown before midlength; tibiæ brown, the tips broadly white on all legs, the amount subequal; tarsi white; claws slender, simple or nearly so. Wings (Plate 1, fig. 4) with a brownish tinge, the oval stigma darker brown; veins dark brown. Costal fringe and macrotrichia of veins relatively long and conspicuous. Venation: Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 not far from its tip; Rs long, gently arcuated; free tip of Sc_2 and R_2 in transverse alignment; m-cu shortly before fork of M; cell 2d A narrow.

Abdomen dark brown, including the hypopygium. Male hypopygium (Plate 2, fig. 27) with the tergite, *9t*, long, narrowed outwardly, the apex shallowly bilobed by a small median notch. Basistyles, *b*, elongate, the ventromesal lobe rounded, basal in position. Dorsal dististyle, *dd*, a chitinized hook, slightly expanded before the acute tip. Ventral dististyle, *vd*, a small oval lobe, set with several long coarse setæ; rostral prolongation slender, terminating in a pale spine; no rostral spines are apparent in the unique type. Gonapophyses, *g*, dusky, the mesal-apical lobe obtuse at apex.

MINDANAO, Surigao Province, Mainit, March 4, 1931 (*Duyag*); holotype, male.

Limonia (*Limonia*) *thctica* is the fourth Philippine species of the subgenus to be described in which not only the tarsi but the tips of at least the posterior tibiæ are snowy white. It differs from *L.* (*L.*) *monilis* sp. nov. and *L.* (*L.*) *multinodulosa* Alexander in the short, nonpedicellate antennæ, and in having the tips of all tibiæ whitened. Its closest ally is *L.* (*L.*) *latiflava* Alexander (Luzon), which is still known only from the female sex. The latter species has the tarsi and tibial tips more yellowish, Sc much longer, ending just before the fork of the long Rs, and cell 2d A wider.

LIMONIA (LIMONIA) SEMANTICA sp. nov. Plate 1, fig. 5; Plate 2, fig. 28.

General coloration of mesonotum reddish brown; pleura variegated with darker; antennæ (male) elongate, moniliform; all tarsi white, the proximal ends of basitarsi restrictedly darkened; halteres pale, the knobs yellow, ringed with darker at base; wings faintly tinged with brown, the oval stigma a trifle darker; male hypopygium with two rostral spines on ventral dististyle; gonapophyses entirely pale, the mesal apical angle a curved pale spine.

Male.—Length, about 3 millimeters; wing, 3.6.

Rostrum small, dark-colored; palpi pale. Antennæ (male) moniliform, the pedicels paler brown than the brownish black enlargements; basal enlargements oval to cylindrical, not at all triangular in outline, provided with long erect setæ and sparse, unilaterally arranged verticils, the latter only a trifle longer than the more-delicate setæ; apical pedicels a little shorter than the bases, becoming still shorter on the outer segments; terminal segment elongate, narrowed at apex. Head blackish.

Mesonotal præscutum reddish brown, the posterior sclerites of mesonotum somewhat darker; præscutum produced cephalad over pronotum. Pleura obscure yellow, variegated with dark brown on anepisternum and on dorsal sclerites. Halteres yellow, the base of the knob narrowly ringed with darker. Legs with the fore coxæ slightly darkened; remaining coxæ and all trochanters more yellowish; femora dark brown, the bases yellowish; tibiæ dark brown; tarsi of all legs chiefly white, the proximal ends of basitarsi infuscated, most extensively so on the fore legs, narrowest on hind legs. Wings (Plate 1, fig. 5) with a faint brown tinge, the oval stigma a trifle darker brown; veins dark. Venation: Sc_1 ending just beyond midlength of Rs, Sc_2 close to its tip; free tip of Sc_2 and R_2 both pale and in approximate transverse alignment; m-cu nearly half its length beyond the fork of M; vein Cu_2 widely separated from Cu_1.

Abdomen brown, the sternites paler. Male hypopygium (Plate 2, fig. 28) with the tergite, *9t*, transverse, the caudal margin not emarginate. Basistyle, *b*, relatively small, the mesal lobe divided into two lobules. Dorsal dististyle, *dd*, a curved chitinized rod, the apex suddenly narrowed to an acute spine. Ventral dististyle, *vd*, small, fleshy; rostral prolongation long and slender, terminating in a single elongate seta; rostral spines basal in position, two in number, placed close together. Gonapophyses, *g*, entirely pale, the mesal apical angle a gently curved pale spine.

MINDANAO, Surigao Province, Mainit, March 4, 1931 (*Duyag*); holotype, male.

Limonia (*Limonia*) *semantica* is very distinct from the other described Philippine species of the subgenus having white tarsi. The closest allies seem to be *L.* (*L.*) *candidella* Alexander and *L.* (*L.*) *subalbitarsis* Alexander, which differ conspicuously in the coloration of the body, the large size, and the structure of the antennæ and male hypopygia. The peculiar lobing of the mesal face of the basistyle of the present species is suggested

by *subalbitarsis*, but the relationship between the two species does not seem to be close.

LIMONIA (LIMONIA) TRIGONELLA sp. nov. Plate 1, fig. 6.

Closely allied to *trigonia*, differing most conspicuously in the very small size.

Female.—Length, about 4.5 millimeters; wing, 5.2.

Rostrum, palpi, and antennæ black. Head black, the anterior vertex silvery.

Mesonotum dark brown, the præscutum with four more-reddish brown stripes. Pleura dark brown. Halteres black. Legs with the coxæ and trochanters ocherous yellow; femora dark brown; tibiæ and tarsi more-brownish yellow. Wings (Plate 1, fig. 6) with a brownish tinge, heavily patterned with dark brown, including five or six major costal areas, and conspicuous seams along cord and outer end of cell 1st M_2; areas in center of cell R_2 and at end of vein R_3 confluent behind, forming a Y-shaped figure, its stem crossing cells R_4, R_5, 2d M_2, and M_3; large areas at arculus and at ends of anal veins; costal areas at origin of Rs, end of Sc and at R_{1+2} very large and only narrowly separated by whitish areas; dark markings of wing conspicuously bordered by whitish.

Abdomen brownish black, the genital segments paler.

MINDANAO, Surigao Province, Mount Cantugas, March 18, 1931 (*Duyag*); holotype, female.

Limonia (*Limonia*) *trigonella* much resembles a tiny specimen of *L.* (*L.*) *claggi* Alexander or *L.* (*L.*) *trigonia* (Edwards), differing most evidently in the very small size. The male is still unknown and will very probably be found to yield distinct hypopygial characters.

LIMONIA (LIBNOTES) ASTUTA sp. nov. Plate 1, fig. 7.

General coloration of mesonotum brown, the lateral portions obscure yellow; wings with a restricted brown pattern; cells C and Sc above the origin of Rs undarkened; cell 1st M_2 shorter than any of the veins issuing from it; vein 2d A strongly arched.

Female.—Length, about 6 millimeters; wing, 7.5.

Rostrum and palpi brownish black. Antennæ brownish black throughout; flagellar segments oval, with short apical necks; verticils short, the longest unilaterally arranged. Head dark gray; anterior vertex reduced to a linear strip that is about as wide as the outer row of ommatidia.

Pronotum dark brown medially, paler laterally. Mesonotum obscure brownish yellow, the median area occupied by a broad dark brown stripe, widened behind by the confluence of the reduced lateral stripes; posterior sclerites of mesonotum dark brown, sparsely pruinose. Pleura more or less darkened, slightly pruinose, the ventral sclerites more yellowish. Halteres dark brown. Legs with the coxæ and trochanters yellow, the fore coxæ more infuscated; femora obscure yellow, passing into dark brown toward tips; tibiæ brown; tarsi broken. Wings (Plate 1, fig. 7) with a pale yellow tinge, cells C and Sc clearer yellow; a restricted dark brown pattern, arranged as follows: A darkening at arculus and in bases of cells R and M; a conspicuous oval seam at end of Sc; stigmal, over the free tip of Sc_2; cord and outer end of cell 1st M_2; R_2; a marginal seam in outer radial field; narrow brown seams on veins R_{2+3} and Cu; veins brown, pale yellow in the flavous costal areas. Macrotrichia of veins long and conspicuous. Venation: Sc_1 ending about opposite r-m, Sc_2 at its tip; free tip of Sc_2 more than its own length before R_2; veins beyond cell 1st M_2 elongate; m-cu before midlength of cell 1st M_2; vein 2d A short.

Abdominal tergites bicolorous, the bases of the individual segments brown, the apices conspicuously yellow; sternites more uniformly yellow, the subterminal segments more darkened. Ovipositor with the cerci shorter than the hypovalvæ, notched at tips; bases of hypovalvæ conspicuously blackened.

MINDANAO, Davao district, Mount Apo, Sibulan River, altitude 7,000 to 8,000 feet, September 21, 1930 (*Clagg*); holotype, female.

Limonia (*Libnotes*) *astuta* is most closely allied to *L.* (*L.*) *banahaoensis* Alexander (Luzon), differing in the body coloration, wing pattern, and venation. The restricted dark pattern of the wings does not include any portion of cells C or Sc above the origin of Rs.

LIMONIA (LIBNOTES) QUADRIPLAGIATA sp. nov. Plate 1, fig. 8; Plate 2, fig. 29.

General coloration of mesonotum dark brown, the præscutum with three more-reddish brown stripes; pleura chiefly dark brown; femora brownish yellow, passing into brown outwardly, the tip narrowly pale yellow; wings light yellow, the costal margin with four conspicuous brown areas; male hypopygium with the outer dististyle and gonapophyses heavily blackened.

Male.—Length, about 8 millimeters; wing, 9.

Rostrum and palpi brownish black. Antennæ with the basal two segments black; flagellum broken. Head gray; anterior

vertex reduced to a narrow strip that is only a trifle wider than the outer row of ommatidia.

Pronotum black. Mesonotal præscutum dark brown, the three stripes more reddish brown, the median one so indicated only in front; scutal lobes conspicuously darkened; median region of scutum and the scutellum more testaceous yellow; postnotal mediotergite dark brown. Pleura chiefly dark brown, vaguely marked with restricted areas of yellowish. Halteres infuscated, the base of stem narrowly yellow; stem conspicuously fringed with long setæ. Legs with the coxæ and trochanters yellow; femora brownish yellow, darkened outwardly, the tips narrowly and abruptly yellow; tibiæ and tarsi brownish yellow, the outer tarsal segments darkened. Wings (Plate 1, fig. 8) light yellow, the costal region clearer yellow; four large and conspicuous brown costal areas, the first above the arculus, the others at origin of Rs, tip of Sc, and tip of R_{1+2}; cord and outer end of cell 1st M_2 narrowly seamed with brown; wing margin narrowly and vaguely darkened, especially in the axillary region. Venation: Sc long, Sc_1 ending about opposite m-cu, Sc_2 at its tip; basal section of R_{4+5} very short, subequal to r-m; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 long and narrow, m-cu at near midlength; vein 2d A beyond base gently converging toward 1st A, thence strongly diverging to margin.

Abdomen bicolorous, dark brown, the caudal margins of the individual segments conspicuously yellow; hypopygium more yellowish. Male hypopygium (Plate 2, fig. 29) with the tergite, *9t*, deeply emarginate medially, each lobe obtusely rounded. Dorsal dististyle, *dd*, a powerful, slightly curved, blackened rod. Ventral dististyle, *vd*, a small suboval lobe, its mesal face produced into two lobules, as figured. Gonapophyses, *g*, with the mesal apical region produced into a powerful blackened beak.

MINDANAO, Davao district, Mount Apo, Baroring River, altitude 6,000 feet, November 10, 1930 (*Clagg*); holotype, male.

By existing keys to the subgenus *Libnotes*, the present species runs to *L.* (*L.*) *longinervis* (Brunetti), from the Indian Himalayas. It is distinguished by the darker coloration of the body, and the different wing coloration and pattern, together with details of venation, as the much longer vein Sc and cell 1st M_2.

LIMONIA (LIBNOTES) HENRICI sp. nov. Plate 1, fig. 9.

Head and thorax, with all appendages, black; wings strongly suffused with brown, the costal region more blackened; abdomen red, the basal tergite and genital segments of both sexes black.

Male.—Length, about 9 millimeters; wing, 10.

Female.—Length, about 12 millimeters; wing, 12.

Head, including appendages, black.

Entire thorax, including halteres and legs, black. Wings (Plate 1, fig. 9) with a very strong brown tinge, the prearcular region, cells C and Sc, and the stigma blackish; veins brown to dark brown. Venation: Sc long, Sc_1 ending nearly opposite m-cu, Sc_2 at its tip; Rs oblique, nearly straight to weakly sinuous; free tip of Sc_2 far before R_2, the distance longer than m-cu; m-cu at near midlength of cell 1st M_2; vein 2d A long, at base converging toward 1st A.

Abdomen with the basal tergite and genital segments of both sexes black, the intermediate region bright red, the lateral line narrowly blackened in male; hypopygium black; valves of ovipositor horn-colored.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet (*Clagg*); holotype, male, October 27, 1930; allotype, female, November 6, 1930.

Limonia (*Libnotes*) *henrici* is named in honor of Mr. J. Henry Clagg, father of the collector of the types. It belongs to the *semperi* group of the subgenus, differing notably from the other included species in having the head and thorax intense black, instead of orange.

LIMONIA (ALEXANDRIARIA) NATHALINÆ sp. nov. Plate 1, fig. 10; Plate 2, fig. 30.

General coloration of mesonotum polished black, including the præscutal shield; pleura yellow, the anepisternum and pteropleurite black, the pleurotergite gray; wings tinged with brown, the prearcular region more yellowish.

Male.—Length, about 4.5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ black throughout; flagellar segments short-oval, the terminal segment not elongated. Head black, the broad anterior vertex and narrow posterior orbits silvery.

Pronotum black, paler laterally. Mesonotal præscutum almost covered by a polished black shield, only the humeral triangles obscure yellow; scutal lobes polished black; median region of scutum and the scutellum testaceous-yellow; postnotal mediotergite black, more or less pruinose. Pleura obscure yellow, the anepisternum and pteropleurite polished black, the pleurotergite heavily gray pruinose. Halteres with the stem pale, the knobs dark brown. Legs with the coxæ and trochan-

ters yellow; femora yellow, the tips narrowly infuscated; tibiæ and tarsi brownish black. Wings (Plate 1, fig. 10) tinged with brownish, the prearcular region more yellowish; stigma very pale brown. Venation: Sc_1 ending far before origin of Rs, the distance about one-half longer than Rs; Sc_1 long; Rs short, a little more than one-half the basal section of R_{4+5}.

Abdomen dark brown, the ventral dististyle of the hypopygium paler. Male hypopygium (Plate 2, fig. 30) with the caudal margin of the tergite, *9t*, very deeply notched, the lateral angles produced into slender lobes that are tipped with long black setæ. Ventral dististyle, *vd*, larger than in *argyrata*, the rostral spines somewhat longer, exceeding the prolongation in length.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, December 29, 1930 (*Clagg*); holotype, male.

Limonia (*Alexandriaria*) *nathalinæ* is named in honor of Mrs. Nathalin Clagg, mother of the collector, Mr. Charles F. Clagg, whose various trips to Mount Apo have added greatly to our knowledge of the distribution of Tipulidæ in Mindanao. It is most closely allied to *L.* (*A.*) *argyrata* Alexander (Formosa, Luzon) differing in the blackened mesonotum, the extensive black areas on the thoracic pleura, and details of structure of the male hypopygium, as the narrower lateral lobes of the tergite and the longer spines of the rostral prolongation of the ventral dististyle.

LIMONIA (ALEXANDRIARIA) TECTA sp. nov. Plate 1, fig. 11; Plate 3, fig. 31.

General coloration yellow, the mesonotal præscutum with a single median black stripe that widens out at the suture, being evidently formed by the confluence of the short laterals with the usual median area; femora obscure yellow, the tips narrowly dark brown; wings subhyaline, the stigma dark brown, clearly defined; Sc_1 very long, exceeding the distal section of M_{1+2}; Rs shorter than the basal section of R_{4+5}.

Male.—Length, about 3.5 millimeters; wing, 4.5.

Female.—Length, about 3.5 millimeters; wing, 4.2.

Rostrum obscure yellow; palpi brownish black. Antennæ brownish black throughout; flagellar segments oval, the terminal segment elongate. Head light brown.

Mesonotal præscutum obscure yellow, the median area with a single black stripe that widens at the suture; a small median area of yellow behind this stripe on præscutum; scutal lobes

brownish black, the median region yellow; scutellum and postnotal mediotergite chiefly darkened. Pleura light yellow. Halteres yellow, the knobs dark brown. Legs with the coxæ and trochanters yellow; femora obscure yellow, the tips narrowly dark brown; tibiæ brown, the tarsi paling to yellow. Wings (Plate 1, fig. 11) subhyaline, the stigma dark brown, clearly defined; veins brownish black. Venation: Sc_1 ending some distance before origin of Rs, the distance on costa being longer than Rs alone; Sc_1 very long, exceeding the distal section of M_{1+2}; Rs shorter than the basal section of R_{4+5}; cell 2d A relatively narrow, the outer end pointed.

Abdominal tergites dark brown, the sternites paler, the more proximal sternites with their bases darkened. Male hypopygium (Plate 3, fig. 31) with the tergite, *9t*, transverse, the caudal margin very gently emarginate. Ventral dististyle, *vd*, a large fleshy lobe, the rostral prolongation bearing a stout powerful spine that is evidently formed by the fusion or very close approximation of two spines.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet (*Clagg*); holotype, female, September 26, 1930; allotype, male, September 9, 1930.

Limonia (*Alexandriaria*) *tecta* differs from the somewhat similar *L.* (*A.*) *argyrata* Alexander (Formosa, Luzon) and *L.* (*A.*) *nathalinæ* sp. nov. in the pattern of the head and thorax, the dark brown, clearly defined stigma, and, especially, the structure of the male hypopygium, notably the feebly emarginate tergite. *Limonia* (*A.*) *brevissima* Alexander (Luzon) has a similarly darkened stigmal area, but is very different in the unusually short, transverse Rs. The present species has Sc_1 longer than any other regional species of the subgenus.

HELIUS (HELIUS) COSTOSETOSUS sp. nov. Plate 1, fig. 12; Plate 3, fig. 32.

General coloration dark brown; legs black, the tarsi paling to brownish yellow; wings grayish subhyaline, cells C and Sc more yellowish; a conspicuous erect costal fringe; cell 1st M_2 small, with m-cu at near midlength.

Male.—Length, about 5.5 to 5.7 millimeters; wing, 6 to 6.2.

Female.—Length, about 6 to 6.5 millimeters; wing, 5.5 to 5.8.

Rostrum dark brown, a little longer than the remainder of head; palpi brownish black. Antennæ dark brown throughout; flagellar segments oval, clothed with a dense erect pubescence and short verticils. Head brownish gray.

Mesonotum chiefly dark brown, the humeral region somewhat brighter. Pleura chiefly dark brown, the ventral sternopleurite a little brightened. Halteres brownish black, the base of the stem narrowly pale. Legs with the coxæ brownish yellow; trochanters obscure yellow; femora yellow at base, the remainder passing to black; tibiæ black; tarsi chiefly brownish yellow, the outer segments brightening to yellow. Wings (Plate 1, fig. 12) grayish subhyaline, cells C and Sc more yellowish; stigma elongate, pale brown; veins dark brown. Costal margin of both sexes, but more especially of the male, with a long erect fringe of setæ. Venation: Sc_1 ending nearly opposite the fork of Rs, Sc_2 at its tip; anterior branch of Rs sinuous, on distal third running close to vein R_{1+2}, the two elements relatively close together at margin; m subequal to the second section of M_{1+2} or the basal section of M_3; m-cu near or beyond midlength of cell 1st M_2.

Abdominal tergites dark brown, the basal sternites yellowish, the outer segments more darkened; hypopygium light brown. Male hypopygium (Plate 3, fig. 32) with the basistyle, *b*, relatively slender. Outer dististyle, *od*, a nearly straight rod, the apex more blackened and weakly bidentate. Inner dististyle, *id*, with the basal two-thirds more enlarged, provided with coarse erect setæ, the distal third narrowed to a flattened bladelike portion that is provided with small delicate punctures. Ædeagus, *a*, long, forming a weak coil.

MINDANAO, Surigao Province, Mount Diuata, April 10 to 17, 1931 (*Duyag*); holotype, male; allotype, female; numerous paratypes of both sexes.

By my key to the Philippine species of *Helius*,[a] the present species runs to couplet 10, where it disagrees with all species in the venation, notably the shape of cell 1st M_2 and the position of m-cu at near midlength of the cell. The long conspicuous costal fringe likewise distinguishes the fly from other forms found in the Islands. From the somewhat similar *H.* (*H.*) *costofimbriatus* Alexander (Riukiu Islands), the present fly is readily told by the details of venation, as the position of m-cu.

HELIUS (HELIUS) DEVINCTUS sp. nov. Plate 1, fig. 13; Plate 3, fig. 33.

General coloration dark brown; antennæ (male) elongate, if bent backward extending nearly to base of abdomen; legs black, the tarsi paling to brownish yellow; wings with a faint brown tinge, cells C and Sc, with the stigma, darker brown; costal

[a] Philip. Journ. Sci. 47 (1932) 184.

fringe short and inconspicuous; m-cu at near midlength of cell 1st M_2; male hypopygium with a hairy lobe on mesal face of basistyle at or beyond midlength.

Male.—Length, about 4 to 4.5 millimeters; wing, 4.5 to 5.

Rostrum brownish black, somewhat longer than the remainder of head; palpi black. Antennæ brownish black, in male of a somewhat unusual length for a member of this genus of flies, if bent backward extending nearly to base of abdomen; flagellar segments cylindrical, clothed with a dense erect pubescence. Head black.

Mesonotum chiefly dark brown, the præscutum vaguely lined with paler, especially near suture; scutellum obscure yellow, darkened medially at base. Pleura conspicuously dark brown on dorsal portion, the ventral sclerites and pteropleurite a little paler. Halteres brownish black. Legs with the coxæ and trochanters yellow to brownish yellow, the fore coxæ somewhat darker; remainder of legs black, the outer tarsal segments paling to brownish yellow. Wings (Plate 1, fig. 13) with a faint brown tinge, cells C and Sc, together with the stigma, darker brown; veins dark brown. Costal fringe short and inconspicuous. Venation: Anterior branch of Rs strongly arcuated at origin, on distal two-thirds extending generally parallel to R_{1+2}; m-cu at or beyond midlength of cell 1st M_2, in approximate transverse alignment with r-m.

Abdominal tergites dark brown, the sternites more reddish brown, the caudal margins of the intermediate segments a trifle darkened; hypopygium yellowish brown. Male hypopygium (Plate 3, fig. 33) with the basistyle, *b*, relatively slender, the mesal face on distal half with a conspicuous hairy lobe. Outer dististyle, *od*, a very slender, nearly straight rod, the apex entire or nearly so. Gonapophyses, *g*, appearing as very slender curved spines from a dilated base.

MINDANAO, Surigao Province, Mainit, March 21 to 27, 1931 (*Duyag*); holotype, male; allotype, female; paratypes, several of both sexes; Mount Cantugas, March 19, 1931 (*Duyag*); paratypes, several of both sexes.

Helius (*Helius*) *devinctus* is generally similar to *H.* (*H.*) *costosetosus* sp. nov., differing most evidently in the elongate antennæ of the male, short costal fringe in both sexes, and the very different structure of the male hypopygium. By my key to the Philippine species of *Helius*,[7] this fly runs to exactly the

[7] Loc. cit.

same place as does *costosetosus*, differing from the various included species in the same characters. The presence of the hairy lobe on the basistyle of the male hypopygium suggests the condition found in the Formosan *H.* (*H.*) *tenuistylus* Alexander and allied species, but the present fly is very different in venation and in details of structure of the hypopygium.

HEXATOMINI

ULA AURITARSIS sp. nov. Plate 1, fig. 14.

General coloration dark brown, including the knobs of halteres; legs brown, the tarsi and narrow tips of the middle and hind tibiæ light yellow; wings strongly infuscated; cell 1st M_2 very small.

Male.—Length, about 6 millimeters; wing, 7.

Female.—Length, about 7 millimeters; wing, 7.

Rostrum and palpi black. Antennæ with the scape and pedicel dark brown, the flagellum black; flagellar segments long-oval. Head dark gray.

Pronotum brownish gray. Mesonotum dark brown, the humeral region of præscutum obscure yellow; median region of scutum and the scutellum obscure brownish yellow, the latter slightly infuscated along caudal margin. Pleura chiefly dark brown, the pteropleurite, ventral sternopleurite, and meral region more yellowish. Halteres obscure yellow, the knobs dark brown. Legs with the coxæ and trochanters obscure yellow; femora brownish yellow, the tips passing to darker brown; tibiæ pale brown, the tips of middle and hind tibiæ narrowly light yellow; tarsi light yellow, the proximal ends of fore basitarsi infuscated. Wings (Plate 1, fig. 14) with a strong brown tinge, the stigma darker; wing base slightly yellowish; veins dark brown. Macrotrichia of cells very abundant beyond cord, in cell M continued basad as a central line of trichia, and along caudal margin of wing as a marginal series in both anal cells. Venation: Cell 1st M_2 very small.

Abdominal tergites dark brown, the sternites more yellowish, subterminal segments ringed with dark brown; hypopygium obscure yellow.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, at trap lantern, January 1, 1931 (*Clagg*); holotype, male; allotype, female.

Ula auritarsis is readily told from *U. mindanica* by the characters given in the accompanying key to the Philippine species of *Ula*.

Key to the Philippine species of Ula.

1. Legs, including the tarsi, dark brown................ *U. mindanica* Alexander.
   Legs dark brown, the tarsi abruptly light yellow.
   U. auritarsis sp. nov.

LIMNOPHILA (LIMNOPHILA) PETULANS sp. nov. Plate 1, fig. 15; Plate 3, fig. 34.

Antennæ with the scape and pedicel brownish black, the flagellum yellow; general coloration of thorax brownish black; knobs of halteres dark brown; legs yellow, the femora with a very vague darker subterminal ring; wings with the ground color pale yellow, with a heavy brown, much broken, ocellate pattern; abdomen, including the hypopygium, dark brown.

Male.—Length, about 5 millimeters; wing, 5.8.

Rostrum and palpi dark brown. Antennæ short; scape and pedicel brownish black, the flagellum pale yellow, the outer segments a trifle darker. Head brownish gray; anterior vertex broad.

Mesonotal præscutum brown, more blackish laterally; posterior sclerites of mesonotum brownish black, sparsely pruinose. Pleura brownish black. Halteres dusky, the knobs dark brown. Legs with the coxæ and trochanters dark brown; femora yellow, with a narrow, vaguely darker ring before the tip; tibiæ and tarsi yellow; the segments with long conspicuous yellow setæ. Wings (Plate 1, fig. 15) with the ground color pale yellowish, very heavily patterned with brown, this pattern arranged chiefly as much broken ocelli, centering about the origin of Rs, the cord, outer end of cell 1st M_2, and the center of the radial field; in addition, all cells of wing with additional spots and dots of brown, those in the costal cell appearing as narrow transverse lines. Costal fringe relatively short. Wing widest just beyond the termination of vein 2d A. Venation: Sc_1 ending opposite fork of Rs, Sc_2 at its tip; R_2 subequal to R_{1+2}; veins R_3 and R_4 diverging strongly at margin, cell R_3 correspondingly widened; m-cu at near one-third the length of cell 1st M_2; vein 2d A ending just basad of the widest part of wing.

Abdominal tergites dark brown, sparsely yellow pollinose; sternites with the central portion obscure yellow, bordered on all sides with darker; hypopygium brownish black. Male hypopygium (Plate 3, fig. 34) with the outer dististyle, *od*, a simple rod, curved at apex to an acute point, the outer fourth or fifth with microscopic setulæ. Inner dististyle, *id*, broad. Gonapophyses, *g*, appearing as long, paddlelike blades.

MINDANAO, Davao district, Mount Apo, Poraka River, altitude 6,500 feet, September 8, 1930 (*Clagg*); holotype, male.

Limnophila (*Limnophila*) *petulans* is most nearly allied to *L.* (*L.*) *murudensis* Edwards (Borneo), differing especially in the uniformly darker body coloration, the dark brown knobs of the halteres, the uniformly yellow tibiæ and tarsi, more-broken ocellate wing pattern, and blackened hypopygium.

Genus PILARIA Sintenis

Subgenus EUPILARIA novum

Generally similar to *Pilaria*, s. s., differing especially in the venation of the radial field of the wing. Tuberculate pits and pseudosutural foveæ present but pale. Antennæ with basal flagellar segments short and crowded, the outer segments with long conspicuous verticils. Wings with the anterior branch of Rs short, about one-third the posterior branch, cell R_3 at margin being some five times as wide as cell R_2; cell M_1 lacking.

Type of the subgenus, *Pilaria phœnosoma* Alexander (Oriental Region).

Besides the type, *Pilaria auranticolor* sp. nov. and *P. leucopeza* Alexander belong to this group. The three known species are found only in the Philippines, but the group will very probably be found to have a much wider range in the Oriental Region.

PILARIA (EUPILARIA) AURANTICOLOR sp. nov. Plate 1, fig. 16; Plate 3, fig. 35.

General coloration fiery orange; antennæ black, the scape brownish yellow; all tarsi brown; wings strongly tinged with fulvous; abdomen orange; male hypopygium with the outer dististyle slender, weakly bidentate at apex; each gonapophysis terminating in two conspicuous spines.

Male.—Length, about 8 millimeters; wing, 8.2.

Head deep orange. Antennæ with the scape brownish yellow, the remainder, including the pedicel, black.

Thorax fiery orange, the scutal lobes and scutellum weakly pruinose. Halteres yellow, the knobs dark brown. Legs with the coxæ and trochanters yellow; femora obscure yellow, the tips narrowly infuscated; tibiæ and tarsi brown. Wings (Plate 1, fig. 16) with a strong fulvous tinge, much brighter than in *phœnosoma;* prearcular and costal regions more yellowish; stigma small, a little darker than the ground color.

Abdomen fiery orange, including the hypopygium. Male hypopygium (Plate 3, fig. 35) with the tergite, *9t*, only slightly produced medially, the central portion irregularly notched, as shown, the lobules formed being densely set with microscopic setulæ. Outer dististyle, *od*, slender, gently curved near apex,

the tip weakly bidentate. Gonapophyses, *g*, slender, each terminating in two spines.

MINDANAO, Surigao Province, Mainit, March 4, 1931 (*Duyag*); holotype, male.

Pilaria (*Eupilaria*) *auranticolor* is closely related to *P.* (*E.*) *phænosoma* Alexander (Luzon), differing most evidently and decisively in the structure of the male hypopygium, especially the conformation of the tergal margin, the slender outer dististyle, and the conspicuous spinous gonapophyses.

ERIOPTERINI

GONOMYIA (LIPOPHLEPS) SAGITTIFERA sp. nov. Plate 1, fig. 17; Plate 3, fig. 36.

Belongs to the *skusei* group; general coloration dark brown; antennæ brownish black throughout; pleura striped longitudinally with whitish; knobs of halteres obscure yellow; legs brownish black; wings brownish gray, the stigma ill-defined; Sc long, Sc_1 ending about opposite one-third the length of Rs; male hypopygium with the outer dististyle a very long, slender, blackened hook.

Male.—Length, about 3.4 to 3.5 millimeters; wing, 4.2 to 4.3.

Rostrum brown; palpi brownish black. Antennæ brownish black throughout, relatively elongate for a member of this group; flagellar segments long-cylindrical, clothed with numerous erect setæ. Head brownish black.

Pronotum pale yellowish white. Mesonotal præscutum dark brown, sparsely pruinose with gray, the extreme lateral margin yellow; pseudosutural foveæ polished, dark colored; median region of scutum obscure yellow, darker behind; scutellum light yellow; postnotal mediotergite brownish gray, the extreme anterolateral portions yellow. Pleura dark brown, sparsely pruinose, with a broad longitudinal whitish stripe occupying the ventral pleurites; sclerites surrounding the wing root obscure yellow. Halteres dusky, the knobs yellow. Legs with the coxæ obscure brownish yellow; trochanters obscure yellow; remainder of legs brownish black. Wings (Plate 1, fig. 17) with a faint brownish gray suffusion, the stigmal region weakly darker; veins dark brown. Venation: Sc long, Sc_1 ending about opposite one-third the length of Rs, Sc_2 some distance from its tip; cell 1st M_2 closed; m-cu near fork of M.

Abdominal tergites dark brown, the sternites obscure yellow; hypopygium obscure yellow. Male hypopygium (Plate 3, fig. 36) with the basistyle, *b*, terminating in two fleshy lobes. Outer dististyle, *od*, a very long, slender, blackened hook that is curved

to the acute point. Inner dististyle a straight to slightly arcuated pale club, the apex of the style slightly dilated and bearing a stout fasciculate seta at inner apical angle. Phallosome, *p*, a massive flattened structure, the ædeagus elongate.

MINDANAO, Davao district, Mount Apo, Sibulan River, altitude 7,000 to 8,000 feet, September 21, 1930 (*Clagg*); holotype, male; paratypes, two males.

Gonomyia (*Lipophleps*) *sagittifera* is very distinct from *G.* (*L.*) *acanthophallus* Alexander (Mindanao) and *G.* (*L.*) *longiradialis* Alexander (Luzon), the most nearly allied regional species of the group, in the large, powerfully constructed male hypopygium.

GYMNASTES (PARAGYMNASTES) HYLÆA sp. nov. Plate 1, fig. 18; Plate 3, fig. 37.

General coloration of mesonotal præscutum brownish yellow, with three nearly confluent shiny black stripes; head yellow; femora black, with a narrow yellow subterminal ring; wings whitish subhyaline, crossbanded with dark brown, including a narrow band at level of origin of Rs, one at cord and the broad apex; cell R_2 very small, strongly narrowed to closed at outer end.

Male.—Length, about 5.5 millimeters; wing, 5.2.

Rostrum and palpi black. Antennæ with the scape and pedicel obscure yellow; flagellum black; flagellar segments short-oval, with elongate, unilaterally arranged verticils; outer segments more elongate. Head obscure yellow.

Pronotum obscure yellow. Mesonotal præscutum brownish yellow, largely covered by three nearly confluent shiny black stripes; lateral margin of præscutum behind the pseudosutural foveæ more obscurely darkened; posterior sclerites of mesonotum chiefly blackened. Pleura dull black, the ventral sternopleurite more reddish brown. Halteres blackened, the apices of the knobs obscure yellow. Legs with the coxæ blackened; trochanters brownish yellow; femora obscure yellow at base, blackened outwardly, with a narrow yellow subterminal ring at nearly three times its width from apex; tibiæ and tarsi blackened. Wings (Plate 1, fig. 18) whitish subhyaline, heavily patterned with dark brown, arranged chiefly as three transverse bands, the basal one at level of origin of Rs narrow and nearly parallel-sided; second band at cord, widest near costa; apical area broadest; cells C and Sc darkened; an isolated brown area covering outer end of cell 1st M_2; vein Cu and axilla weakly seamed with brown. Costal fringe conspicuous. Venation:

Cell R_2 reduced to a tiny triangle by the approximation of veins R_{1+2} and R_3.

Abdominal tergites black, the caudal margins of the segments restrictedly pale; sternites similar, the yellow incisures somewhat more extensive in area. Male hypopygium (Plate 3, fig. 37) with the dististyle, *d*, a simple, obtusely rounded plate. Ædeagus, *a*, an elongate compressed blade.

MINDANAO, Surigao Province, Mainit, March 4, 1931 (*Duyag*); holotype, male.

Gymnastes (*Paragymnastes*) *hylæa* is most nearly allied to *G.* (*P.*) *pictipennis* Edwards (Siam) in the general pattern of the legs and wings, and the venation, especially the much-reduced cell R_2. It differs in the variegated coloration of the thorax and abdomen, the wing pattern, especially the narrow basal fascia, and the structure of the male hypopygium, especially of the dististyle.

I have here restricted the subgeneric term *Gymnastes* to include only the species having cell R_2 entirely obliterated by the fusion of veins R_2, R_3, and R_{1+2}. The more-numerous species of the genus having cell R_2 present are placed in the modified subgenus *Paragymnastes* Alexander, which has hitherto included only species from the Australasian Region. The distinctions between the two groups are admittedly very weak but parallel corresponding distinctions found in the closely allied genera *Teucholabis* Osten Sacken (with *Paratropesa* Schiner) and *Gonomyia* Meigen (with *Lipophleps* Bergroth and *Ptilostenodes* Alexander). *Gymnastes* seems distinct from *Teucholabis* in the scaly covering of the legs and in the manner in which cell R_2 has been lost by the approximation and fusion back from the margin of the veins that inclose it.

TEUCHOLABIS (TEUCHOLABIS) RUTILANS sp. nov. Plate 1, fig. 19; Plate 3, fig. 38.

General coloration of thorax polished reddish orange; head black, sparsely pruinose; antennæ black throughout; halteres black; legs black, the femora with a conspicuous yellow ring on apical half; wings with slightly more than the basal half whitish, the distal portion and costal region dark brown; Sc long; cell 1st M_2 closed; abdomen black.

Male.—Length, about 7.5 millimeters; wing, 7.5.

Rostrum and palpi black. Antennæ black throughout; basal flagellar segments globular, the smaller outer segments passing into oval; verticils of moderate length, exceeding the segments. Head black, sparsely pruinose, especially on anterior vertex.

Pronotum, mesonotum, and pleura polished reddish orange, the meral region blackened. Halteres short, brownish black. Legs with the fore and middle coxæ reddish orange, the posterior coxæ and trochanters black; femora black, with a conspicuous yellow ring beyond midlength; tibiæ and tarsi black; legs stout and conspicuously hairy. Wings (Plate 1, fig. 19) with the costal region and approximate distal half of wing dark brown, the proximal portions whitish; the darkened areas include the prearcular region, cells C and Sc, the radial field except the proximal ends of cells R_1, R_4, and R_5, and a linear streak in center of cell R_2; distal third of cell 1st M_2 and outer three-fourths of cell M_4 darkened; veins dark. Venation: Sc long, Sc_1 ending at near two-thirds the length of Rs, Sc_2 at near midlength of origin of Rs and tip of Sc_1; veins R_4 and R_5 long and extending generally parallel to one another; cell 1st M_2 closed; m-cu less than its length beyond fork of M.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 38) with the outer apical angle of basistyle, *b*, produced into a slender black spine. Dististyle, *d*, as shown, the outer apical angle produced into a slender lobe that bears two setæ.

MINDANAO, Davao district, Mount Apo, Sibulan River, altitude 2,000 feet, October 11, 1930 (*Clagg*); holotype, male.

Teucholabis (*Teucholabis*) *rutilans* is very different from the remaining species of the genus in the Philippines. It is somewhat similar in general features to *T.* (*T.*) *plecioides* de Meijere (Java), differing especially in the pattern of the legs and wings. The known Philippine species of the genus may be separated by the following key:

Key to the Philippine species of Teucholabis.

1. Cell 1st M_2 open by atrophy of basal section of M_3 .... 2.
   Cell 1st M_2 closed .... 3.
2. Cell 2d M_2 relatively shallow, shorter than its petiole. (Luzon.)
   T. (*T.*) *confluenta* Alexander.
   Cell 2d M_2 deep, about one-half longer than its petiole. (Mindanao.)
   T. (*T.*) *confluentoides* Alexander.
3. Wings pale yellow, the narrow apex and a crossband at cord pale brown; costal fringe (male) long and conspicuous. (Luzon.)
   T. (*T.*) *quinquemaculata* Alexander.
   Wings either uniformly darkened (*majuscula*) or else dimidiate, the basal half whitish, the distal portion darkened (*rutilans*); costal fringe short in both sexes .... 4.
4. Legs uniformly blackened; wings uniformly suffused with yellowish brown. (Mindanao.) .... *T.* (*T.*) *majuscula* Alexander.

Legs black, the femora with a conspicuous yellow ring on distal half; wings dimidiate, whitish, the distal half or a little less darkened. (Mindanao.) .... *T.* (*T.*) *rutilans* sp. nov.

TAIWANINA MINDANICA sp. nov. Plate 1, fig. 20.

General coloration dark brown; pronotum obscure yellow; a silvery white longitudinal stripe on thoracic pleura; halteres yellow, the knobs blackened; femora black, the bases yellowish, most extensively so on posterior legs; wings cream-yellow, with a handsome brown pattern, arranged more or less reticulately; distal section of Cu_1 short, about one-half m-cu; abdominal sternites two to six, inclusive, with paired whitish spots at base.

Male.—Length, about 6.5 millimeters; wing, 6.4.

Rostrum nearly as long as remainder of head, black, the mouth parts much reduced to virtually lacking. Antennæ with the scape and pedicel black, the flagellum brownish yellow, passing into darker brown outwardly; fusion segment elongate, involving about seven or eight segments, the outer flagellar segments with their sutures lacking or nearly so, delimited chiefly by constrictions and the arrangement of the long conspicuous verticils; terminal segment slender, linear. Eyes very large, with coarse ommatidia; vertex reduced to a narrow strip; eyes broadly contiguous beneath. Head dark brownish gray.

Pronotum obscure yellow, with a brown lateral spot. Mesonotal præscutum strongly produced over the pronotum, as in the genus, dark brown, narrowly bordered in front with yellow, the brown passing into brownish black laterally, forming an abrupt contrast with the yellow border; posterior sclerites of notum dark brown. Pleura black, with a broad silvery white longitudinal stripe extending from the propleura, passing beneath the root of the halteres; dorsopleural membrane pale yellow, variegated with brownish black. Halteres pale yellow, the knobs blackened. Legs with the coxæ and trochanters brownish black; bases of femora narrowly yellow, passing into black, the amount of yellow most extensive on the posterior legs where more than the basal half is included; tibiæ yellow, the base and apex narrowly whitened; basitarsi yellow, narrowly dark brown at proximal end; remainder of tarsi yellow. Wings (Plate 1, fig. 20) with the ground color cream-yellow, handsomely patterned with dark brown and grayish brown, the darkened areas more or less reticulate; large areas at origin of Rs and stigma, with narrow seams along cord and outer end of cell 1st M_2, connected with a reticulate area in center of outer radial field;

bases of cells R and M restrictedly darkened; a dusky wash in bases of cells M and Cu; dark marginal clouds at near midwidth of anal cells; veins black, C, Sc, and R light yellow. Venation: Much as in *pandoxa,* differing in certain details; Rs spurred at origin; distal section of Cu_1 very short, about one-half m-cu and diverging strongly from it; anal veins bent strongly to margin.

Abdomen black; sternites two to six, inclusive, with conspicuous paired whitish spots at base; hypopygium black.

MINDANAO, Davao district, Mount Apo, Baroring River, altitude 7,000 feet, November 8, 1930 (*Clagg*); holotype, male.

The discovery of a second species of *Taiwanina* is of much interest. The type and only previously known species is *T. pandoxa* Alexander (Formosa). In characters the present species conforms very closely to the genotype and so adds little to our knowledge of the exact position of the group. The fusion segment of the antennæ is even more profound than in *pandoxa,* and the sutures between the remaining flagellar segments are scarcely indicated. The short rostrum, with greatly reduced mouth parts, the anteriorly produced præscutum, and the venation are all much as in the genotype. In the structure of the head, as the rostrum and antennæ, and of the thorax, as the produced præscutum and the extensive sternopleurite, the resemblance to *Toxorhina* is well indicated. I cannot but feel that the group is closer to *Toxorhina* than to the Heliaria, despite the simple setæ of the legs and the general structure of the male hypopygium, the latter being similar in general features to members of the Heliaria. *Taiwanina mindanica* is readily told from *T. pandoxa* by the diversified wing pattern and the very short distal section of vein Cu_1.

TRENTEPOHLIA (MONGOMA) PERSIMILIS sp. nov.

Male.—Length, 8 to 9 millimeters; wing, 7.5 to 8.

Female.—Length, 8.5 to 9 millimeters; wing, 8.

Very similar to *T.* (*M.*) *brevifusa* Alexander (Luzon), differing chiefly in the longer legs and darker coloration of the body. Mesonotum uniformly dark brown, the ventral pleurites paler. Setæ of body longer and more conspicuous, including the two groups on the sternopleurite and the series on the præscutal interspaces. Apical fusion of veins Cu_1 and 1st A very slight to almost lacking.

MINDANAO, Surigao Province, Mainit (*Duyag*); holotype, male, March 22, 1931; allotype, female, March 25, 1931; para-

topotype, 1 male, with allotype; paratypes, males and females, Mount Cantugas, March 17, 1931; males and females, Diuata Mountains, April 10, 1931.

TRENTEPOHLIA (MONGOMA) ALBOTERMINALIS sp. nov. Plate 1, fig. 21.

General coloration of mesonotum dark brown; head black, with median carina on vertex; legs dark brown, the tarsi and tips of all tibiæ white; wings grayish subhyaline; inner end of cell M_3 lying far proximad of cells R_5 or 2d M_2.

Male.—Length, 5.5 to 6 millimeters; wing, 5 to 6.

Rostrum yellowish brown. Antennæ brownish black throughout. Head black, the vertex with a median carina.

Mesonotum dark brown, the præscutum paler laterally. Pleura obscure yellow, the dorsal portions darker. Halteres short, dusky, the extreme base of stem yellow. Legs with the coxæ and trochanters obscure yellow; femora and tibiæ dark brown, the tips of the latter abruptly white, the amount subequal on all legs and including about the outer tenth of the segment; tarsi white; fore femora on basal portion with a few erect stout setæ. Wings (Plate 1, fig. 21) grayish subhyaline, the costal region narrowly darker; veins brown. Venation: Cell R_3 large; inner end of cell M_3 lying far proximad of either R_5 or 2d M_2; apical fusion of veins Cu_1 and 1st A slight.

Abdomen, including hypopygium, dark brown.

MINDANAO, Surigao Province, Mainit (*Duyag*); holotype, male, March 24, 1931; paratype, male, March 23, 1931.

Trentepohlia (*Mongoma*) *alboterminalis* is readily told from the other described regional species of the subgenus *Mongoma* by the conspicuous whitened tips of all tibiæ. By my latest key to the Philippine species of *Trentepohlia*,[a] the present species runs to *T.* (*M.*) *pennipes* (Osten Sacken), a very different species with feathered mid-tibiæ.

TRENTEPOHLIA (ANCHIMONGOMA) BEATA sp. nov. Plate 1, fig. 22.

General coloration brownish black; legs brownish black, the tarsi chiefly snowy white; wings with more than the cephalic half strongly suffused with blackish, the posterior portions more grayish.

Male.—Length, about 6 millimeters; wing, 5 to 5.5.

Female.—Length, 6 to 6.5 millimeters; wing, 5 to 5.5.

Rostrum and palpi black. Antennæ black throughout, relatively elongate in male, if bent backward extending about to

[a] Philip. Journ. Sci. 43 (1930) 297-298.

base of abdomen; flagellar segments cylindrical, with verticils shorter than the segments. Head black.

Mesonotum almost uniformly dark brown. Pleura dark brown dorsally, the ventral pleurites more yellowish. Halteres black, the base of stem restrictedly pale. Legs with the coxæ and trochanters yellowish brown; femoral bases pale, the remainder dark brown; tibiæ entirely brownish black; tarsi snowy white, with nearly the proximal half (fore legs) to third (posterior legs) brownish black. Wings (Plate 1, fig. 22) with a strong blackish suffusion on more than the cephalic half, the posterior portion, including cells R_5 to 2d A, more grayish; veins dark brown. Venation: Sc_1 ending opposite or shortly before proximal end of R_2; Sc_2 shortly before fork of Rs.

Abdominal tergites, including hypopygium, black; basal sternites obscure yellow.

MINDANAO, Surigao Province, Diuata Mountains, April 10, 1931 (*Duyag*); holotype, male; Mount Cantugas, March 19, 1931 (*Duyag*); allotype, female; paratypes, several of both sexes, with the types.

Trentepohlia (*Anchimongoma*) *beata* is very distinct from the only other Philippine species of the subgenus, *T.* (*A.*) *apoicola* Alexander, in the pattern of the legs, with no white on the femoral tips of tibial bases. The species is more nearly allied to the subgenotype, *T.* (*A.*) *simplex* (Brunetti), of India, differing conspicuously in the coloration of the wings and legs.

ILLUSTRATIONS

[Legend: *a*, aedeagus; *b*, basistyle; *dd*, dorsal dististyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *p*, phallosome; *s*, 9th sternite; *t*, 9th tergite; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. ***Dolichopeza*** **(*Nesopeza*)** ***abdita*** sp. nov., wing.
2. ***Dolichopeza*** **(*Nesopeza*)** ***inornatipes*** sp. nov., wing.
3. ***Limonia*** **(*Limonia*)** ***monilis*** sp. nov., wing.
4. ***Limonia*** **(*Limonia*)** ***thetica*** sp. nov., wing.
5. ***Limonia*** **(*Limonia*)** ***semantica*** sp. nov., wing.
6. ***Limonia*** **(*Limonia*)** ***trigonella*** sp. nov., wing.
7. ***Limonia*** **(*Libnotes*)** ***astuta*** sp. nov., wing.
8. ***Limonia*** **(*Libnotes*)** ***quadriplagiata*** sp. nov., wing.
9. ***Limonia*** **(*Libnotes*)** ***henrici*** sp. nov., wing.
10. ***Limonia*** **(*Alexandriaria*)** ***nathalina*** sp. nov., wing.
11. ***Limonia*** **(*Alexandriaria*)** ***tecta*** sp. nov., wing.
12. ***Helius*** **(*Helius*)** ***costosetosus*** sp. nov., wing.
13. ***Helius*** **(*Helius*)** ***devinctus*** sp. nov., wing.
14. ***Ula auritarsis*** sp. nov., wing.
15. ***Limnophila*** **(*Limnophila*)** ***petulans*** sp. nov., wing.
16. ***Pilaria*** **(*Eupilaria*)** ***auranticolor*** sp. nov., wing.
17. ***Gonomyia*** **(*Lipophleps*)** ***sagittifera*** sp. nov., wing.
18. ***Gymnastes*** **(*Paragymnastes*)** ***hylæa*** sp. nov., wing.
19. ***Teucholabis*** **(*Teucholabis*)** ***rutilans*** sp. nov., wing.
20. ***Taiwanina mindanica*** sp. nov., wing.
21. ***Trentepohlia*** **(*Mongoma*)** ***alboterminalis*** sp. nov., wing.
22. ***Trentepohlia*** **(*Anchimongoma*)** ***beata*** sp. nov., wing.

PLATE 2

FIG. 23. ***Dolichopeza*** **(*Nesopeza*)** ***abdita*** sp. nov., male hypopygium.
24. ***Dolichopeza*** **(*Nesopeza*)** ***inornatipes*** sp. nov., male hypopygium, details.
25. ***Dolichopeza*** **(*Nesopeza*)** ***bicornigera*** sp. nov., male hypopygium, details.
26. ***Dolichopeza*** **(*Nesopeza*)** ***ridibunda*** sp. nov., male hypopygium, details.
27. ***Limonia*** **(*Limonia*)** ***thetica*** sp. nov., male hypopygium.
28. ***Limonia*** **(*Limonia*)** ***semantica*** sp. nov., male hypopygium.
29. ***Limonia*** **(*Libnotes*)** ***quadriplagiata*** sp. nov., male hypopygium.
30. ***Limonia*** **(*Alexandriaria*)** ***nathalina*** sp. nov., male hypopygium.

PLATE 3

FIG. 31. ***Limonia*** **(*Alexandriaria*)** ***tecta*** sp. nov., male hypopygium.
32. ***Helius*** **(*Helius*)** ***costosetosus*** sp. nov., male hypopygium.
33. ***Helius*** **(*Helius*)** ***devinctus*** sp. nov., male hypopygium.
34. ***Limnophila*** **(*Limnophila*)** ***petulans*** sp. nov., male hypopygium.
35. ***Pilaria*** **(*Eupilaria*)** ***auranticolor*** sp. nov., male hypopygium.
36. ***Gonomyia*** **(*Lipophleps*)** ***sagittifera*** sp. nov., male hypopygium.
37. ***Gymnastes*** **(*Paragymnastes*)** ***hylæa*** sp. nov., male hypopygium.
38. ***Teucholabis*** **(*Teucholabis*)** ***rutilans*** sp. nov., male hypopygium.

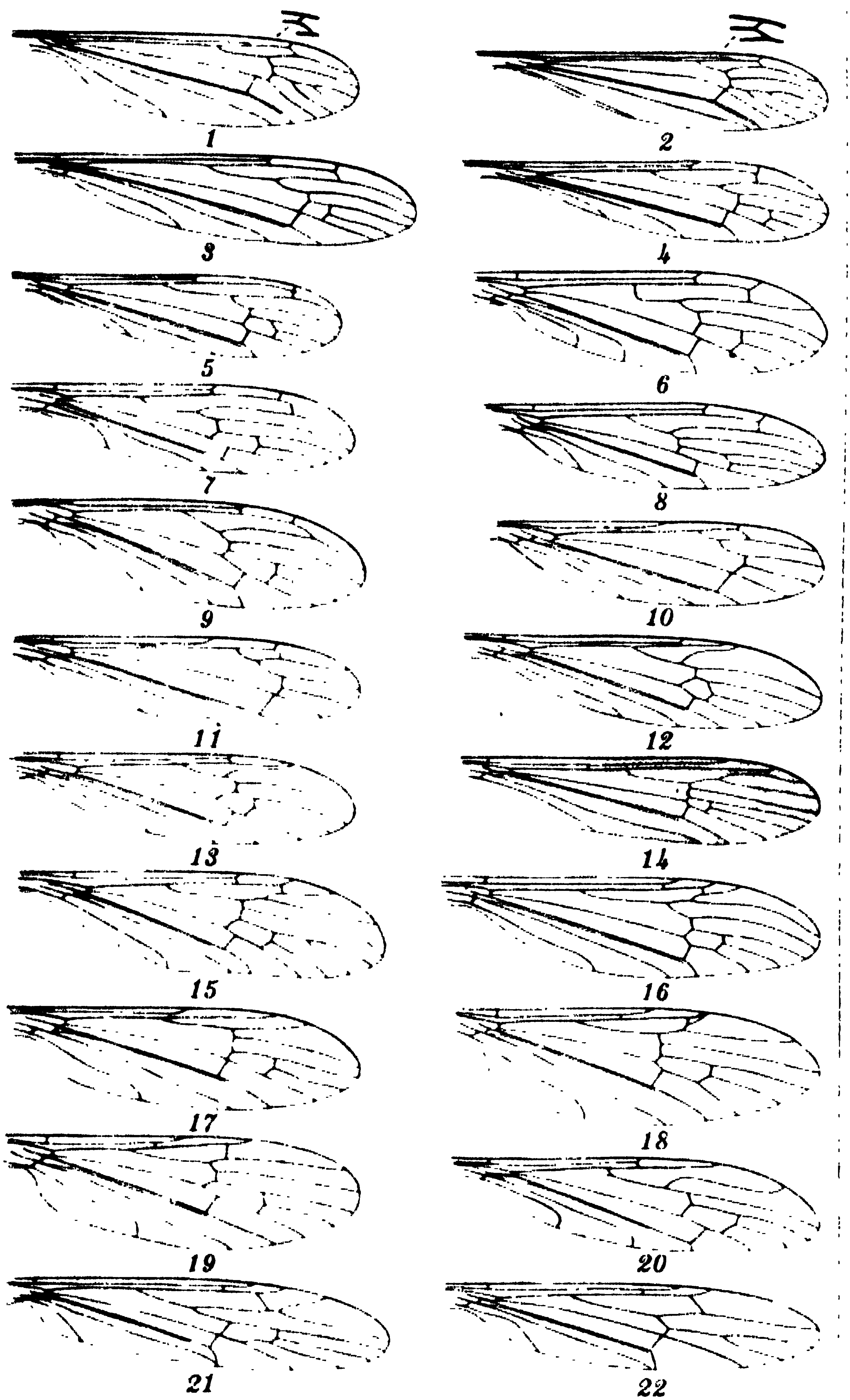
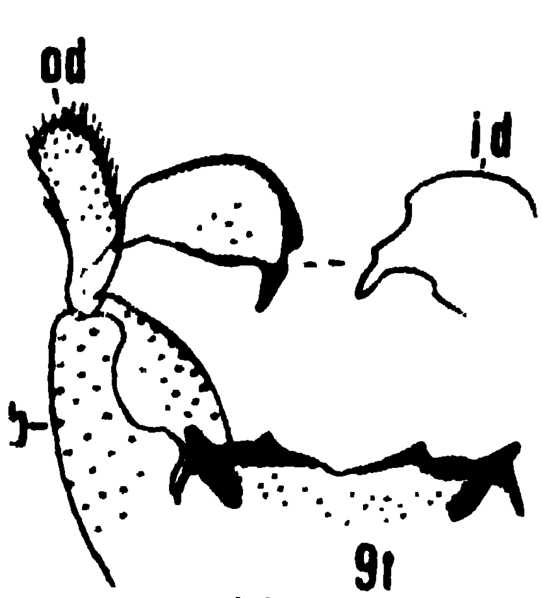


PLATE 1.



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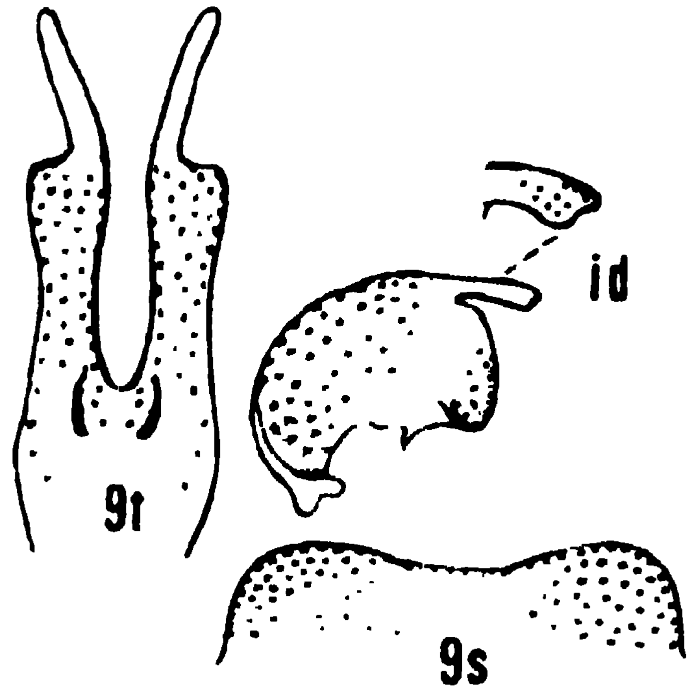

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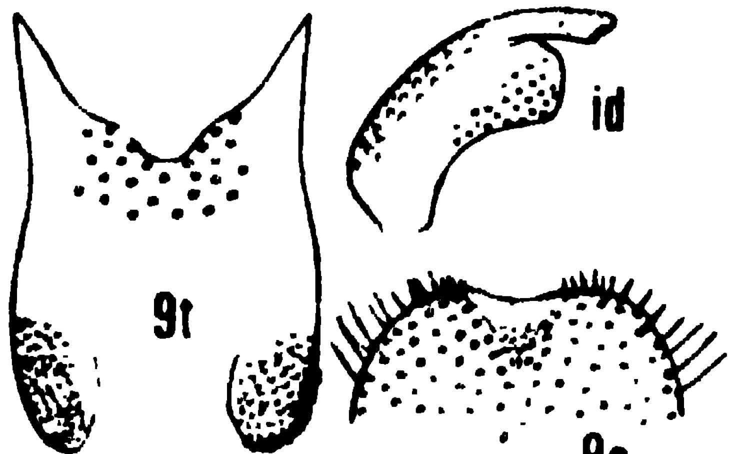

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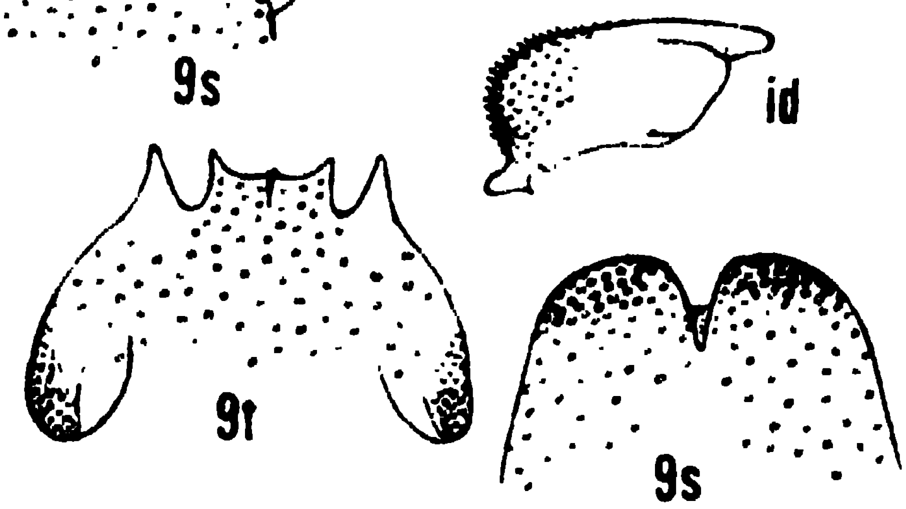

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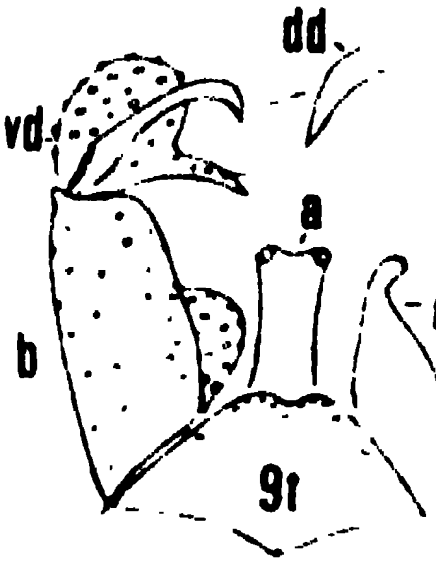

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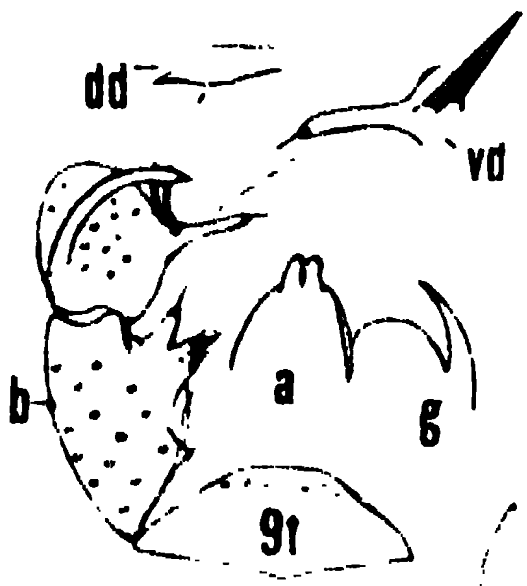

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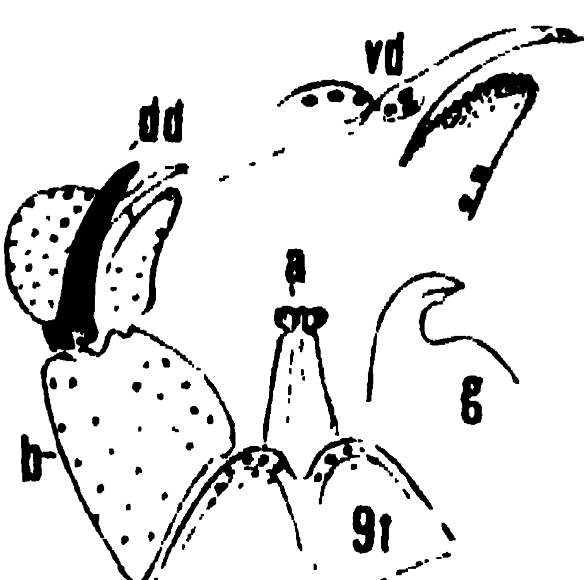

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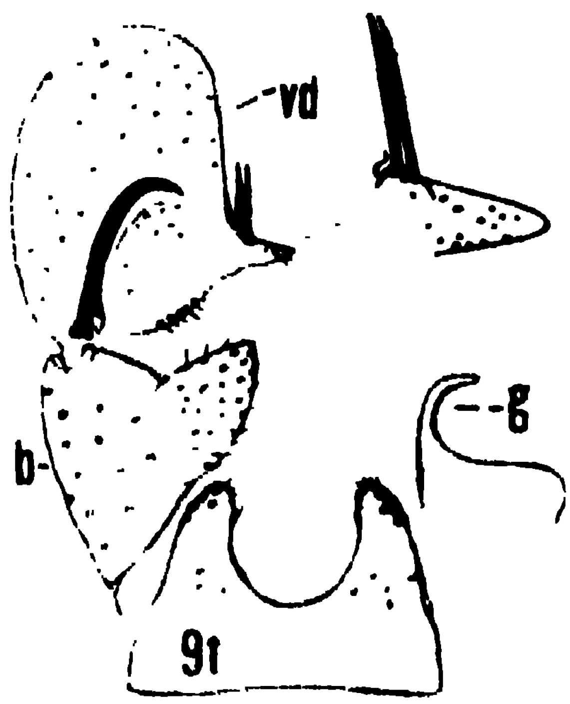

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PLATE 2.

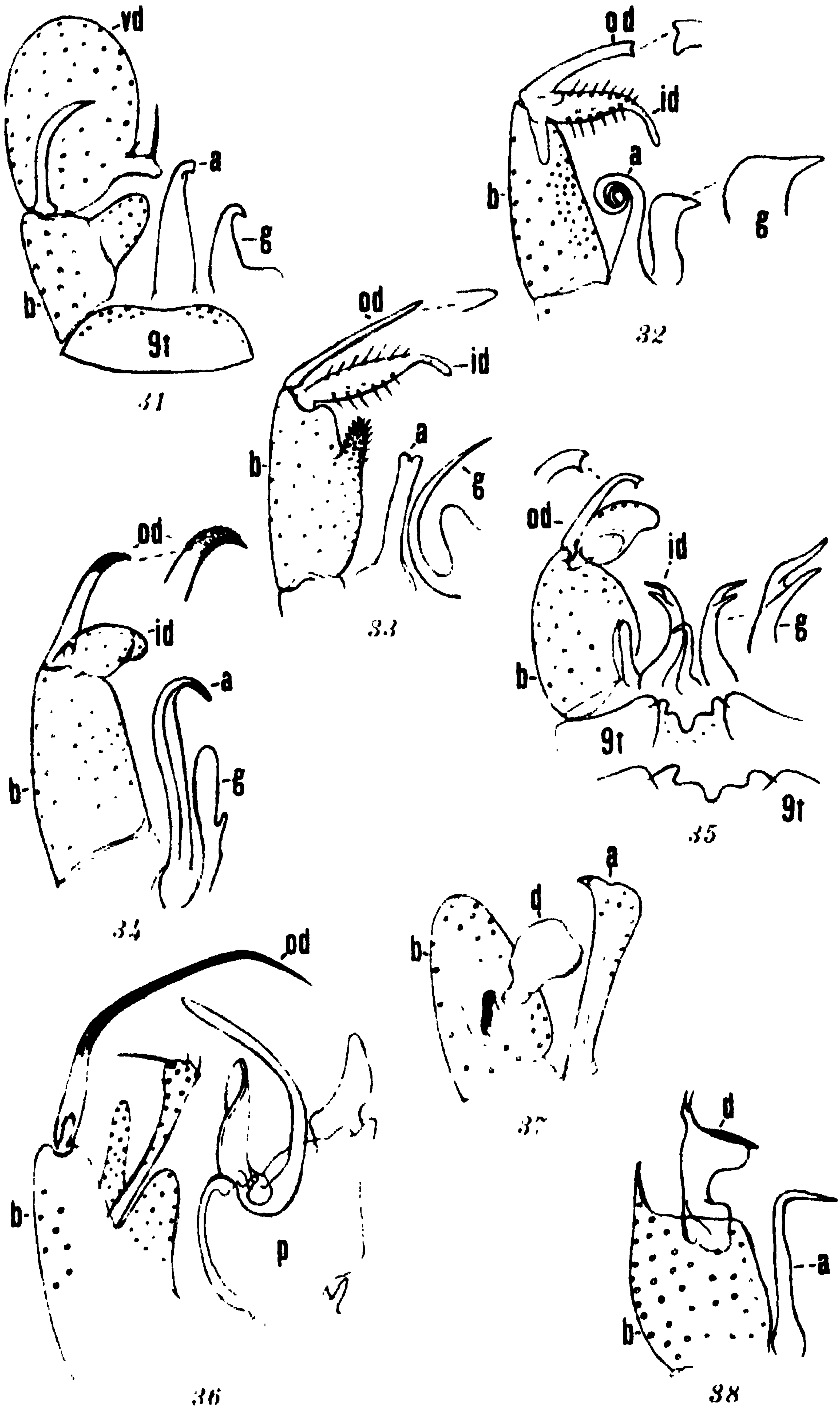
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PLATE 3.

TWO NEW CONIFER-INFESTING SCALE INSECTS FROM JAPAN

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THREE TEXT FIGURES

ASPIDIOTUS MAKII sp. nov.

Scale of female.—Elongate oval, convex; white or dirty white. Exuviæ subcentral, orange yellow; usually covered with a white waxy substance. Ventral scale very thin; when removed the insect leaves a white patch on the host. Length, about 1.5 millimeters; width, about 1.

FIG. 1. Pygidium of *Aspidiotus makii* sp. nov.

Scale of male.—Similar to that of the female, elongate, white, subtransparent. Exuvia a little to one side, orange yellow. Length, about 1.3 millimeters; width, 0.7.

Body of female.—Nearly circular, narrowing towards posterior end. Mouth parts large, well chitinized, rostral loop very long. Antennæ rudimentary, conical, single jointed with a long spine. Spiracles rather large, with no parastigmatic gland orifice.

Pygidium of female.—Rather large, margin round. One pair of lobes, prominent, broader than long to a greater or less extent, notched on each side; no indication of second and third lobes. Two distinct lateral incisions on each side of the margin, bounded by conspicuous thickenings, the inner the larger. Plates small, rather inconspicuous, two between the median lobes, which are much shorter than the lobes and fimbriated at extremity; four or five along the margin, laterad of the median lobe, they are rather long and usually laterally fimbriated. Spines strongly developed, as shown in the figure. Paragenital gland orifice wanting. Dorsal gland orifices fewer, slender, more or less regularly arranged in three series. Transverse basal thickening fairly developed, laterals separated from the central line and robust. Apical ventral chitinization weakly developed. Anal opening large and nearer to the margin than the base of the pygidium.

Habitat.—On *Pinus luchuensis* (Ryukiu matsu). Found by Mr. Yoshitada Maki, of the Kagoshima Sugar Experiment Station, in Wada-mura, Amami-Oshima, December 27, 1930.

This new scale insect is allied to *Aspidiotus ucæ* Comstock and *A. ulmi* Johnson in the pygidial structures in general, but differs from them in the shape of the median lobes, and is readily distinguishable from these two species. The species is named for Mr. Maki, the collector of the type specimens.

ASPIDIOTUS PSEUDOMEYERI sp. nov.

Scale of female.—Elongate oval or irregularly circular, convex. Dull greenish yellow; older specimens dirty pale yellow with posterior margin brown. Mouth parts large, well developed, rostral loop short. Spiracles with no parastigmatic gland orifice. Antennæ minute, conical with a spine.

Pygidium of female.—Broadly round, not heavily chitinized. Two pairs of lobes prominent, well chitinized; median pair largest, apices round with no notch on either side; second pair much smaller but the same general shape as the median; a third pair is present, conical, often very small and obscure. Incisions moderate, very distinct. Paraphysis practically wanting. Plates broad, branched, extending but slightly beyond the lobes, two between the median lobes, two between the median and second lobes, and three between the second and third lobes. Spines usual, as shown in the figure. Anal opening large, circular, placed nearer to the margin than the base of the pygidium. Dorsal pores rather large, not regularly arranged.

Paragenital gland orifices in four groups, each group with few pores as shown in the following examples:

4–4 4–3 3–2
2–2 2–2 2–1

Basal thickenings represented by two median transverse rods and the widely separated oblique lateral thickenings; ventral thickenings normal, but slightly chitinized.

Habitat.—On *Juniperus chinensis* (Ibuki or biyakushin). Collected by Mr. T. Mayeda, of Yokohama, March 25, 1930. Previously collected by the writer in the same place.

FIG. 2. Pygidium of *Aspidiotus pseudomeyeri* sp. nov.

This new scale insect is very closely allied to *Aspidiotus meyeri* Marlatt, but diverges from the latter in the following structural features:

A. meyeri.	*A. pseudomeyeri.*
With a distinct notch on either side of the median and second lobes.	None.
With four of five branched plates following the third lobe.	None.

While the writer was working with the conifer-infesting *Aspidiotus*, he had the opportunity of examining *Aspidiotus abietis* (Schr.) from Mississippi and from Italy. In going through Japanese forms and comparing these two foreign specimens with them, the writer came to the conclusion that *Aspidiotus abietis* is not found in Japan. At the same time he has noted that the American specimen, although named *Aspidiotus abietis*, is *Aspidiotus pini* Comstock instead. Some writers have placed *A.*

pini Comstock as a synonym of *A. abietis* (Schr.), but they are distinct species and can be easily separated by the following characters as shown in the figures:

A. pini.	*A. abietis.*
About one-third of the distance from the third lobe to the penultimate segment is a lobe of the lateral margin of the pygidium, about the size of the third lobe.	No such lobe on the margin.
Dorsal pores are very numerous.	Dorsal pores are not so numerous.

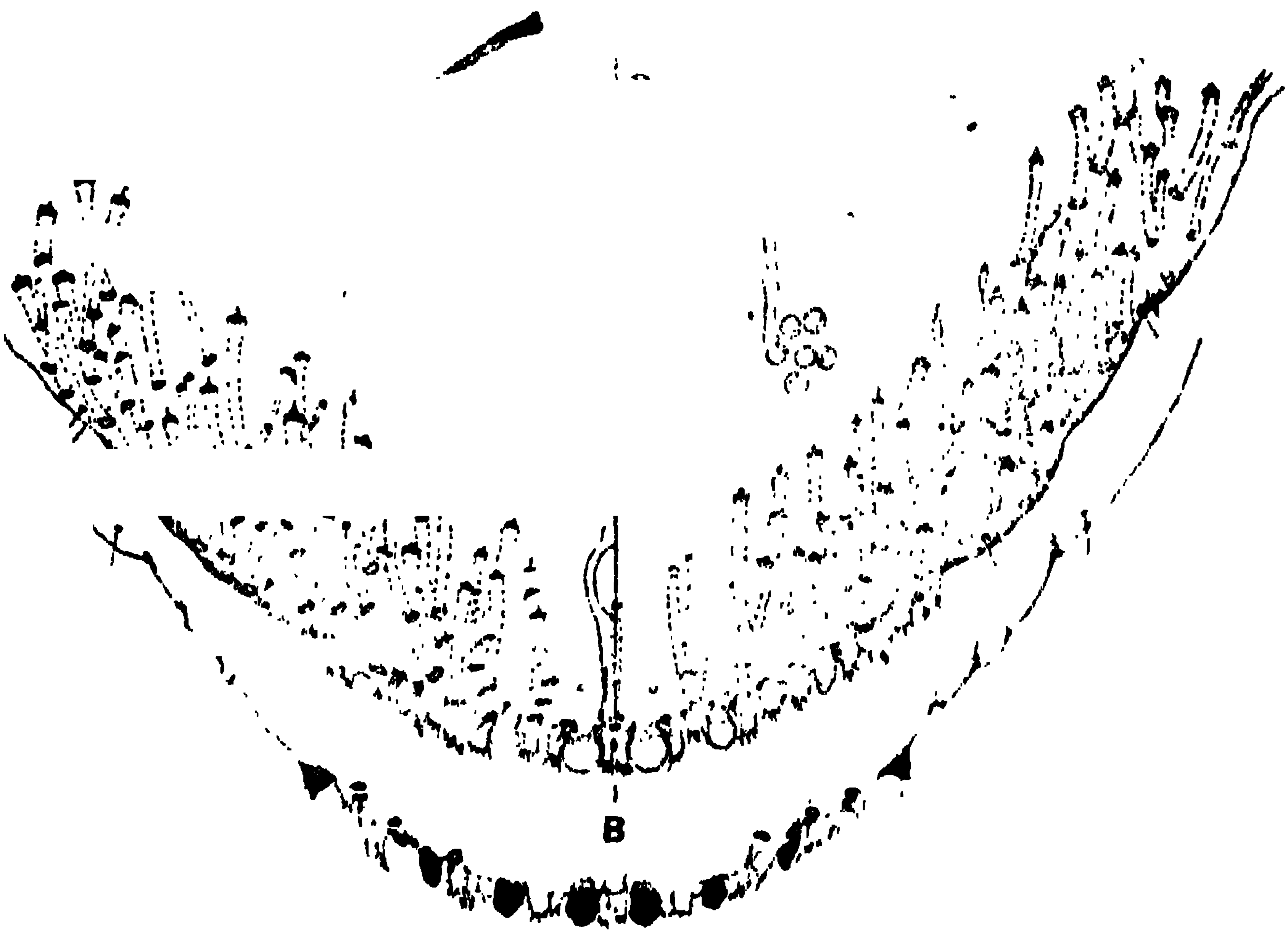

FIG. 3. *a.* Pygidium of *Aspidiotus abietis* (Schr.); *b.* margin of pygidium of *Aspidiotus pini* Comstock.

ACKNOWLEDGMENT

The writer's thanks are due to Dr. Harrold Morrison, United States Bureau of Entomology, Washington, D. C., for his courtesy in examining specimens, and for his assistance in their determination. The writer is also greatly indebted to Dr. F. Silvestri, of Italy, and to Mr. L. E. Myers, of Mississippi, who kindly furnished material for comparative study.

Tokyo, Japan, October 6, 1931.

ILLUSTRATIONS

TEXT FIGURES

THE GENUS ACLERDA IN JAPAN, INCLUDING FORMOSA

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FOUR TEXT FIGURES

INTRODUCTION

The present paper is made up of descriptions and notes on the known Japanese species of the genus *Aclerda*, subfamily Aclerdinæ, family Coccidæ, of which there are three in all. One is described here for the first time and the two other species are redescribed from new material collected by the writer and his assistants.

The writer's thanks are due to Messrs. E. E. Green and R. Newstead, of England, and to Mr. T. V. Nam Ayyar, of South India, for their courtesy in supplying the writer with material for comparative study. The writer's thanks are also due to Mr. Ryoichi Takahashi, of the Government Institute of Formosa, for presenting him with a species from the island.

Genus ACLERDA Signoret

The body of the adult female is thick, fleshy, almost soft, more or less hemispherical oval; creamy white with dark brown caudal end. Unprotected portions of the body covered with closely felted white wax, and those portions, dorsal and ventral, in contact with the food plant covered with a white mealy secretion.

Antennæ represented only by minute setiferous tubercles. Mouth parts well back from the front. Thoracic spiracles conspicuous, no stigmatic cleft nor specialized stigmatic spines. Legs wanting. The lateral margins of the body are usually covered with tuberculate setæ. Anal segment characterized by an undivided median plate enclosed in a somewhat deep cleft. Anal tube ending in many long spines (in the case of *A. biwakoensis* the spines are very short).

All the known larvæ are similar in their excessively elongated form. The margins of the body are nearly parallel, with a

regular series of short, blunt spines. Antennæ and legs well developed. Anal lobes not prominent, each with a long hair.

Usually found beneath the leaf sheaths or on roots of various gramineous plants.

Three known species in Japan, may be separated by the following key:

Key to the species of Aclerda.

a^1. Anal plate circular with apex distinctly cleft .... *A. tokionis.*

a^2. Anal plate with apex never cleft.

b^1. Anal plate broadly round .... *A. biwakoensis.*

b^2. Anal plate triangular .... *A. takahashii.*

DESCRIPTION OF SPECIES

ACLERDA TOKIONIS (Cockerell).

Sphaerococcus (Pseudolecanium) tokionis COCKERELL, Psyche 7; Suppl. 1 (1896) 19; U. S. Dept. Agr., Technical Series, Bull. 4 (1896) 49.

Pseudolecanium tokionis (Cockerell), COCKERELL, Proc. Acad. Sci. Philadelphia (1899) 263; KUWANA, Proc. Cal. Acad. Sci. III 2 (1901) 403; 3 (1902) 57.

Aclerda tokionis (Cockerell), FERNALD, Cat. Coc. World (1903) 211; KUWANA, Imperial Agr. Exp. Sta. Japan Bull. 1 (1907) 117; KUWANA, Nippon Kaigaramushi Zusetsu 2 (1917) 44; FERRIS, Standford Univ. Biol. Ser. 1, No. 1 (1920) 133; TEAGUE, Annals Ent. Soc. Am. 18 (1925) 439; KUWANA, Oyo-Dobutsugaku Zasshi, No. 3, 3 (1931) 231.

Adult female.—Usually broadly oval in outline. Color of the body at first milky white and soft with the postabdominal margin castaneous, later the body becomes tinged with pink, and the castaneous area greatly extended with the deposition of denser chitin until finally the whole of derm may become hardened, and of a reddish brown color (dried specimens dark brown). The unprotected part of the body covered with white waxy filaments, and those portions, dorsal and ventral, in contact with the food plant with a white mealy secretion.

Antennæ very minute, consisting of one joint, conical, with a number of rather strong spines. Eyes apparently wanting. Mouth parts small, set well back from the front, and placed immediately below the anterior pair of spiracles; rostral loop very short; mentum monomerous. Spiracles large and prominent, the aperture of each with a crowded group of parastigmatic glands in a densely chitinized border. Legs wanting.

Posterior end of the abdomen with the wrinkling at the extreme margin of the body. Anal extremity with a distinct cleft.

Anal plate nearly circular with a broad notch in the posterior margin, bearing on each side of the margin about five hairy spines, and covering the extremity of the anal tube. Anal tube terminating in many very large, prominent spines that form a ring.

Posterior margin in the vicinity of the anal cleft with a number of rather long hairy spines. Marginal tuberculate setæ or spines rather small, bluntly pointed, strongly fusiform, forming

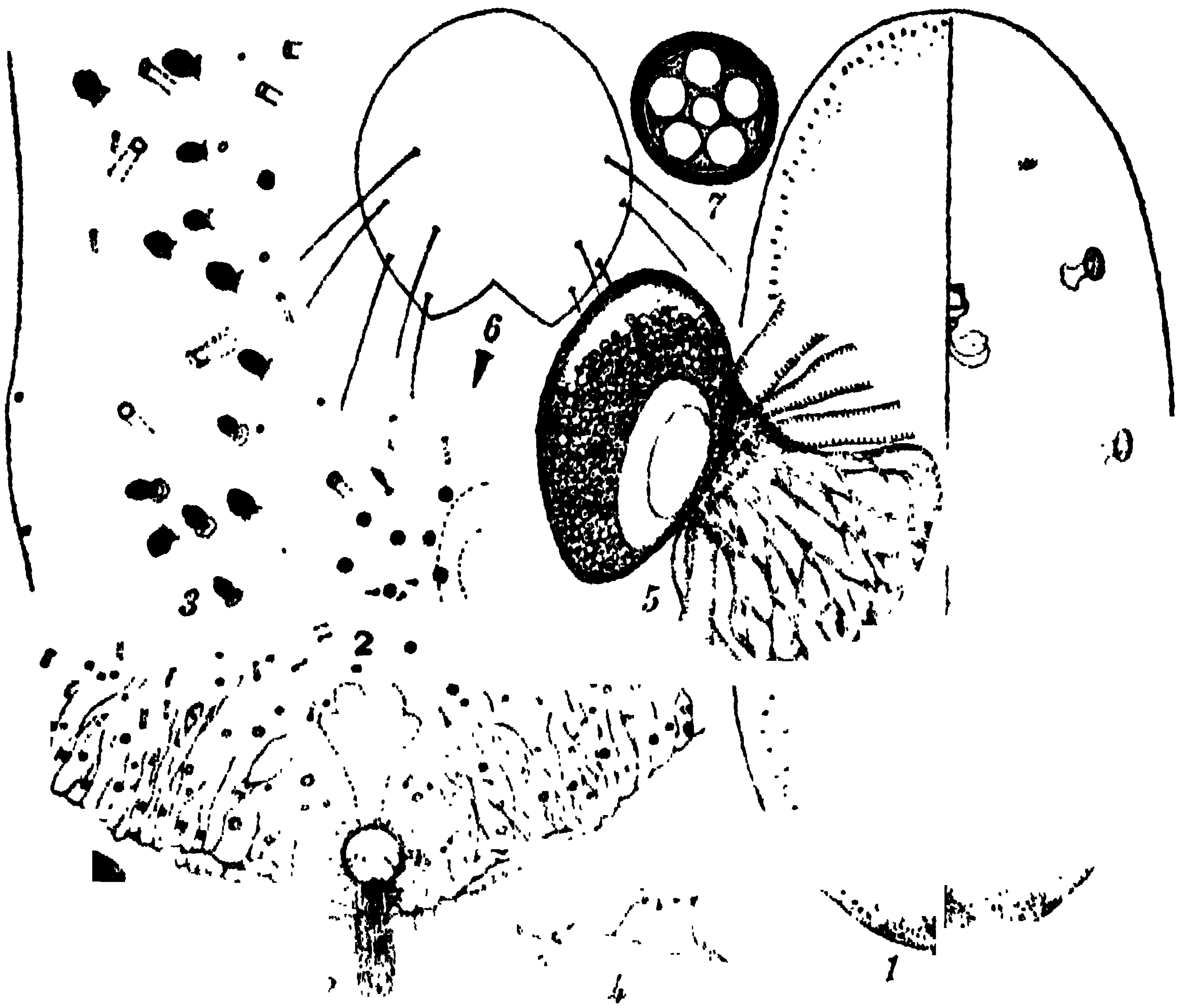

FIG. 1. *Aclerda tokionis* (female); *1*, adult female; *2*, abdominal end; *3* and *8*, margin with spines; *4*, antenna, *5*, spiracle; *6*, anal plate; *7*, multilocular pore. (All figures greatly enlarged.)

a narrow zone which extends to the margins of the anal cleft. Dermal pores occur sparsely all over the body, but are more numerous in the marginal area. These are in two forms, one short and stout, the other small and slender. Lying in the area of tuberculate spines is a zone of multilocular pores, these being lacking on the anterior portion beyond the posterior pair of spiracles.

Length, 4 to 6 millimeters; width, 2 to 3.

Adult male.—Elongate, narrow. General color pale pink; two basal joints of antennæ pink, other joints of antennæ and legs pale brown; ocelli black; wings slightly tinged with brown. Head nearly round, pointed in front. Ocelli four, two dorsal

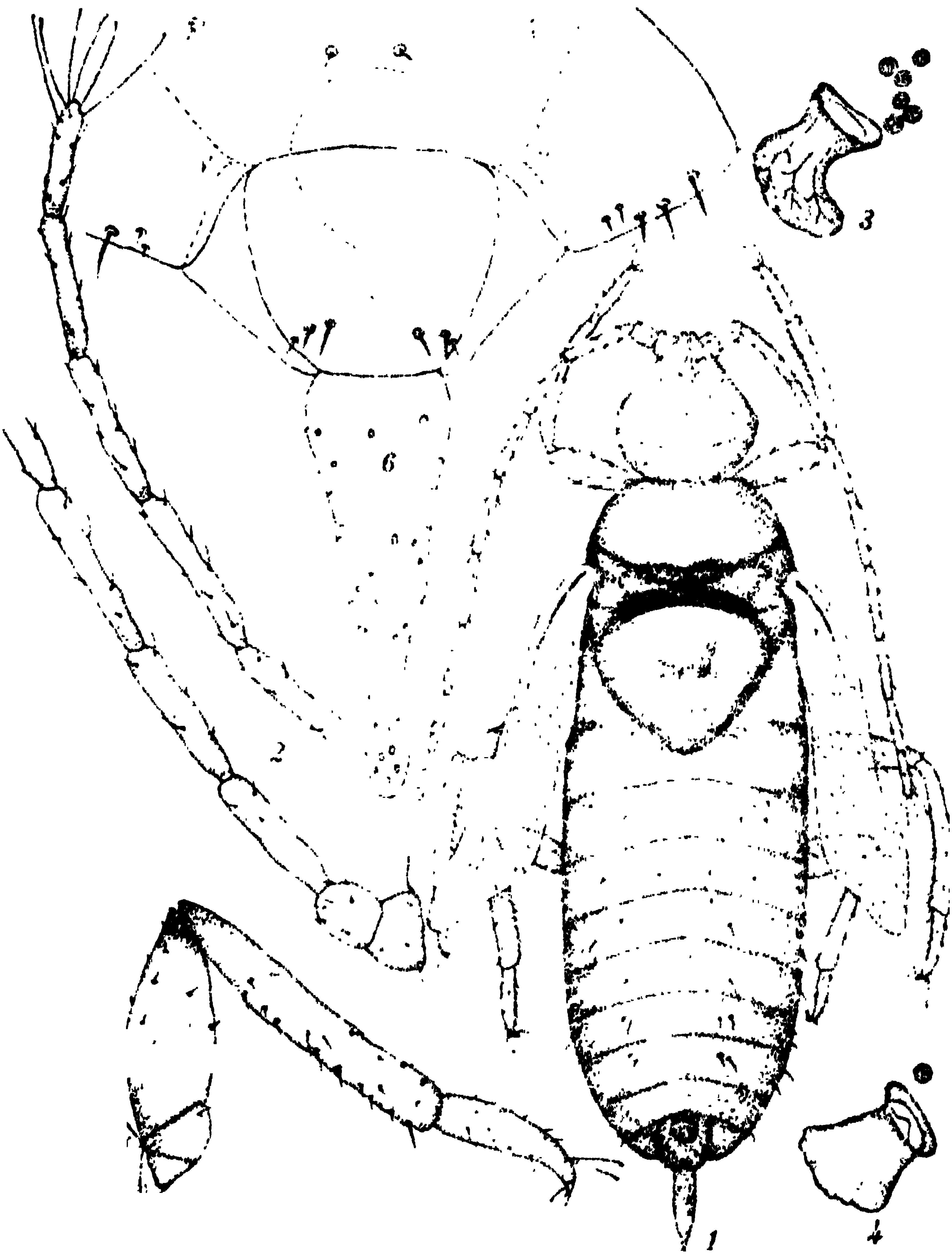

FIG. 2. *Aclerda tokionis* (male): *1*, adult male (dorsal view); *2*, antenna; *3*, anterior spiracle; *4*, posterior spiracle; *5*, hind leg; *6*, abdominal end. (All figures greatly enlarged.)

and two ventral; eyes minute, rudimentary, lateral. Antennæ ten-jointed, slender; first joint very short and stout; second somewhat longer than the first; other joints more slender and nearly equal in length, except the two terminal joints, which are somewhat shorter; each joint with scattered fine hairs, each almost as long as the joint itself. Thoracic region slightly narrower than the abdomen; prothorax short, mesothorax large and well developed, notal plate of mesothorax small; scutellum large and prominent, metathorax shorter than mesothorax. Wings large and narrow, rather thick, reaching about to the fourth abdominal segment, covered with minute hairs; halteres are not observed. Legs comparatively stout, covered with minute hairs; trochanter with a long hair and a well-developed transverse fold; femur much shorter than tibia; tarsus about one-third the length of the tibia, and more or less tapering towards the extremity; claw short and curved; digituies on tarsus and claw fine hairs, knobbed apically, the tarsal pair much the longer. Spiracles rather small, the anterior pair with about six multilocular pores, with only one in the posterior pair. Abdomen oval in shape, slightly wider than thorax, tapering towards the posterior end. The penis is formed from the ninth segment, and its enlarged base is enclosed slightly within the eighth segment. The penis is in the form of a long, slender, tapering stylus, slightly enlarged at the tip.

Length about 1.4 millimeters, width 0.4; length of wing, about 0.45; width, 0.10.

Male pupa.—Elongate in form, pinkish in color with antennæ and legs brown. Antennæ long and slender, reaching to the base of second legs, tapering towards the extremity. Wing case narrow and long, reaching to base of last legs.

Length, about 1.04 millimeters; width, 0.36.

Cocoon of male.—Elongate, subtransparent, white. Length, about 1 millimeter; width, 0.65.

Larva, first stage.—Oblong oval, narrow, segments distinct, sides nearly parallel. Pale yellowish in color with antennæ and legs pale. Antennæ rather short, six jointed; distinctly constricted between the joints; second joint shortest and the third longest; formula usually 3, 6, 5, 1, 4, 2. Legs long, three pairs subequal; femur slightly longer than tibia; claw slender, curved; digitules usual. Four capitate spines on dorsal side of caudal margin, the extremity with a deep cleft, and a small hair on each side. Caudal hairs rather long. Anal ring without hairs. A row of capitate spines all round the margin.

Length, about 1.5 millimeters; width, about 0.4.

Eggs.—Eggs in the body of the female elongate, pale yellow.

Habitat.—Beneath the leaf sheaths of the host plant, causing the sheaths to swell out at those points that cover the insects. This insect is ovoviviparous, but the eggs can be observed inside of the female. The young larvæ appear about early summer. The adult males are found in February. One generation a year, and the insect passes the winter in the stage of the adult female.

The host plants known at present in Japan are the following species of bamboo: *Yadakeya* (*Arundinaria*) *japonica* (yadake), *Pleisblastus chino* (Azuma sasa), and *Pleisblastus graminea* (Taimin chiku).

The scale insect is known from Japan, and the United States of America. In Japan it is commonest about Tokyo City; and, heretofore, it was collected in the following places beside Tokyo-fu: Fukushima, Saitama, Chiba, Kanagawa, Shizuoka, Aichi, Miye, and Gifu-ken.

Notes.—This insect was first discovered on bamboo in Tokyo by Mr. Otoji Takahashi, and was described by Prof. T. D. A. Cockerell in 1896. It was first found in California by the writer, on the campus of Leland Stanford Junior University in 1899. It is a native of Japan, and was probably introduced into California.

Although Mr. M. M. Teague has failed to note the marginal spines accompanied by a zone of stellate circular pores in the adult female of this species, the writer has seen the pores distinctly, around the margin caudate of about the posterior pair of spiracles to the caudal end; however, the pores are wanting in approximately the anterior half.

Since *Aclerda japonica* Newstead was found on *Arundinaria japonica* (Yadake), the writer has had some suspicion that it might prove to be this species, *Aclerda tokionis;* however, this problem cannot be solved without a comparative study of these two forms, which cannot be made at present.

ACLERDA TAKAHASHII Kuwana.

Aclerda japonica Takahashi (not of Newstead), TAKAHASHI, Research Inst. Government of Formosa, Dept. Agr. Report No. 48 (1930) 136.

Aclerda takahashii Kuwana (MS), KUWANA, Oyo-Dobutsugaku Zasshi No. 3, 3 (1930) 231.

Adult female.—Elongate oval in form with the posterior extremity more or less distorted in the old female; heavily chitinized. Color not observed. Antennæ very minute, consisting

of a single joint carrying a number of rather strong spines. Mouth parts small, set well back from the frons, placed between the anterior pair of spiracles, rostral loop very short, mentum monomerous. Eyes obsolete. Spiracles much smaller when compared with *A. tokionis*, but the same in general shape, the aperture of each with numerous small pores. Legs wanting.

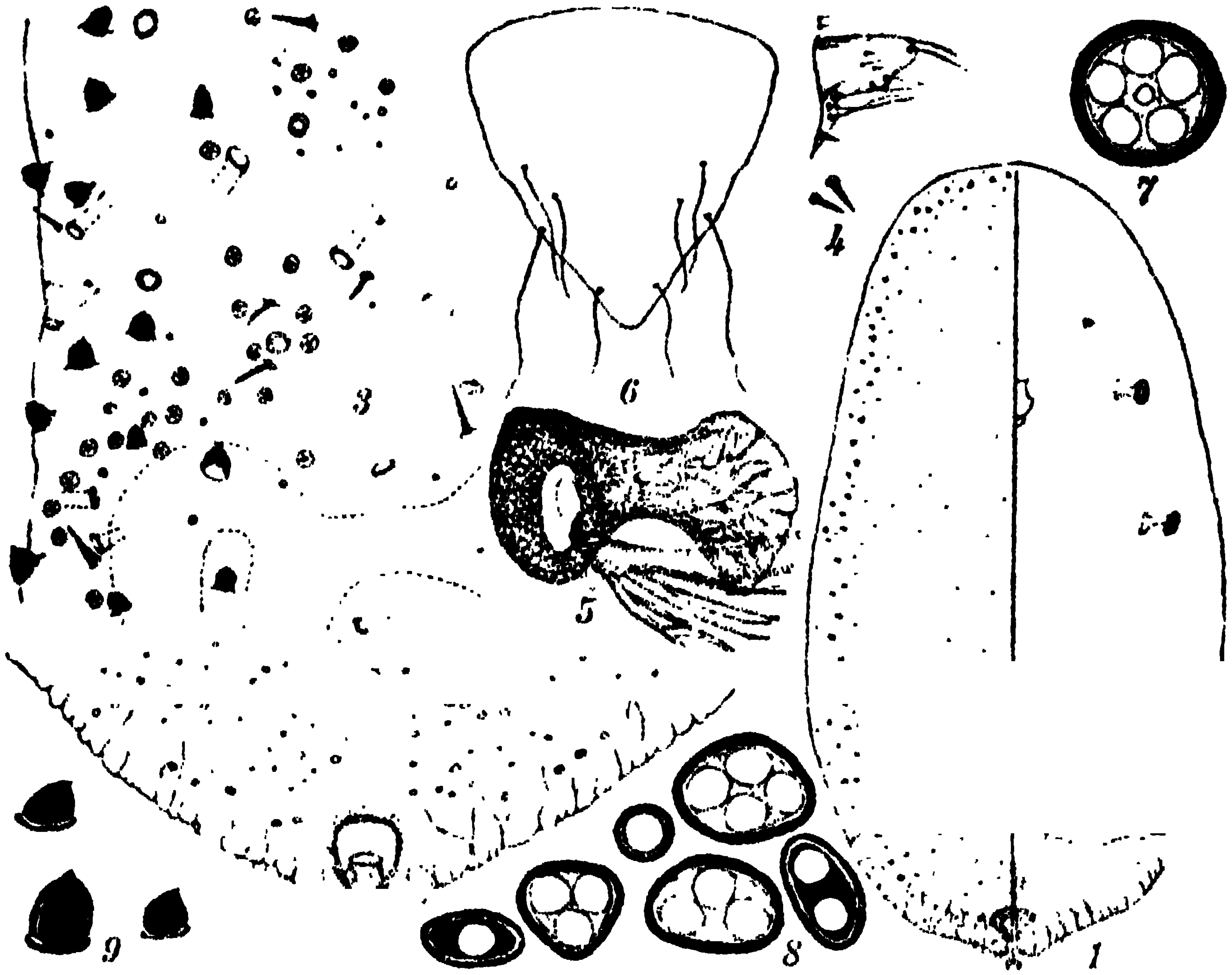

FIG. 3. *Aclerda takahashii* (female); 1, adult female, 2, abdominal end; 3 and 9, margin with spines; 4, antenna; 5, spiracle; 6, anal plate; 7 and 8, multilocular pores. (All figures greatly enlarged.)

Anal extremity with a distinct anal cleft. Plate large, triangular in form, the apical extremity rounded, never cleft, with four rather long whiplike hairs on each side. Anal opening surrounded by many long hairs as in *A. tokionis*, and extending beyond the caudal end. Posterior margin in the vicinity of the anal cleft with many long, stout hairs. Marginal tuberculate spines or setæ in an irregular row that extends around the body except for a narrow region on each side of the anal cleft; the spines vary somewhat in size but all are of the same general shape, being broad at the base and terminating in a sharp point, which gives them a characteristic "acorn shape." Lying within the area of the tuberculated spines is a zone of multilocular pores, especially on the caudal margin up to about the

anterior pair of spiracles. Dorsal pores scarce; they are in two types, large and small, the former more numerous.

Length, 3 to 6 millimeters; width, 2 to 4.

Habitat.—On *Saccharum officinarum* (sugar cane), Kori, Shinka, Formosa. Received a few mounted specimens from Mr. Ryoichi Takahashi, Taihoku, Formosa, in the summer of 1931.

The adult female of this insect resembles *A. tokionis* in general shape, but differs much in the shape of the anal plate, which is triangular with no cleft instead of round with a deep cleft. This triangular anal plate more nearly approaches that of *A. attinuata*, from which it can at once be separated by the arrangement of the hairs. Named in honor of Mr. R. Takahashi, who kindly furnished the writer with the material. This is the first description of the insect.

ACLERDA BIWAKOENSIS Kuwana.

Aclerda (?) *biwakoensis* KUWANA, Imperial Agr. Exp. Station of Japan, Bull. 1, No. 2 (1907) 187; COCKERELL, Can. Ent. 41 No. 2 (1907) 55; SANDERS, Cat. Rec. Desc. Cocc. 2, U. S. Dept. Agr. Tech. Ser. 16, pt. 3 (1909) 47.

Aclerda biwakoensis KUWANA, Nippon Kaigaramushi Zusetsu pt. 2 (1917) 76; TEAGUE, Ann. Ent. Soc. Am. No. 4, 18 (1925) 440.

Adult female.—Broadly oval to elongate in outline. Creamy color with a pinkish shade; when dried, it turns chestnut brown. Sides of the body nearly parallel and anterior end round, gradually broadening on the abdominal region with two shallow invaginations on each side of the body. Caudal extremity noticeably invaginated. More or less covered with a white waxy secretion.

Antennæ slightly conical, single jointed; bearing several strong spines. Mouth parts small, but well chitinized, rostral loop short, placed on the ventral surface, below the anterior pair of spiracles. Spiracles rather large, the aperture with a crowded group of parastigmatic glands in a densely chitinized border as in the preceding species. Eyes and legs wanting.

Anal cleft shallow, only visible on the dorsal surface, with a broadly round plate which bears six short spines on each side. Anal openings on the ventral side of this plate, which bears six very fine hairs in ring. Marginal tuberculate spines or setæ in a row, which extend around the body, increasing in number about the cleft. Spines, acorn shaped, but more or less curved at the tips. Numerous multilocular pores grouped about the spiracles. Derm with short tubular pores and fine hairs.

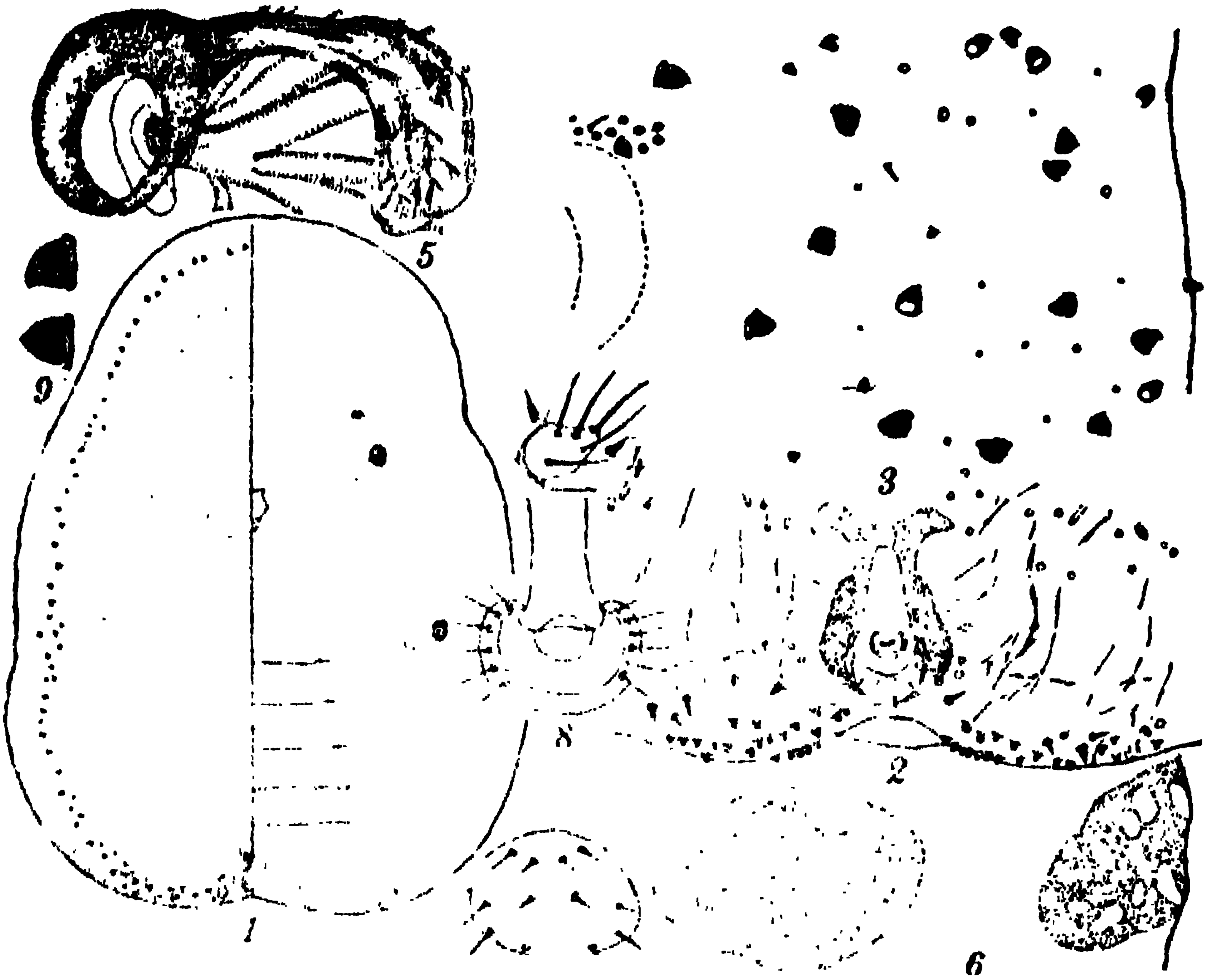

FIG. 4. *Aclerda biwakoensis* (female). 1, adult female; 2, abdominal end; 3 and 9, margin with multilocular pores; 4, antenna; 5, spiracle; 6, markings on dermes; 7, anal plate; 8, anal ring. (All figures greatly enlarged.)

Marginal area with irregularly round markings as shown in the figure.

Length, 6 to 8 millimeters; width, 5 to 6.

Habitat.—Beneath leaf sheaths of the food plant *Phragmites communis* (yoshi). This insect was originally described by the writer in 1917, from material personally collected on the host plant, which was growing on the shores of Lake Biwa, Shiga-ken. Since then the insect has been found by the writer and others in Fukui, Grifu, Aichi, Nara, and Miye-ken on the same host.

Notes.—On account of the anal cleft having a single plate, tuberculate or capitate spines along the margin of the adult female, and the shape of the newly hatched larva, the writer has for the present placed this insect in the genus *Aclerda;* however, it seems to him that as there is a great difference in the structure of the end of the anal tube, which bears very fine hairs instead of long, prominent ones, it might be advisable to establish a new genus.

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Tokyo, Japan, September 30, 1931.

ILLUSTRATIONS

TEXT FIGURES

ADDITIONS TO THE APHID FAUNA OF FORMOSA (HEMIPTERA)

By Ryoichi Takahashi

Of the Department of Agriculture, Government Research Institute Taihoku, Formosa

TWO TEXT FIGURES

Since the preparation of my revision of the Aphididæ of Formosa [1] several other species have been found in Formosa, which are here dealt with. The type specimens will be preserved in the Department of Agriculture, Government Research Institute, Formosa. I express here my sincere thanks to Dr. A. Mordvilko, of Leningrad, for his kindness in identifying specimens.

MYZUS CIRCUMFLEXUS Buckton.

Buckton, Monog. Brit. Aphid. 1 (1876) 130; Theobald, Journ. Econ. Biol. 8 (1913) 116; van der Goot, Contr. Fauna Indes Neerl. 1, 3 (1917) 50; Swain, Univ. Calif. Pub. Tech. Bull. Ent. 3 (1919) 74; Blanchard, Physis 5 (1922) 213; Theobald, Plant Lice Brit. 1 (1926) 331; Hori, Hokkaido Agr. Expt. Sta. Rept. No. 23 (1929) 87; Knowlton, Can. Ent. 61 (1929) 10; Nevsky, Monog. Aphid. Middle Asia (1929) 119.

Host.—*Smilax* sp.

Habitat.—Taihezan (altitude about 5,500 feet).

A few specimens were collected by the author May 21, 1931. New to the fauna of Formosa.

LACHNUS NIGRIPES sp. nov.

Wingless viviparous female.—Dark brown, somewhat shining. Antennæ dark brown. Cornicles black. Cauda black on the hind margin in specimens treated with potash. Abdomen without dusky patches, but with a broad dusky band in front of the cauda. Legs black, femora somewhat paler on both ends in specimens treated with potash. Body oval, broad, about 3.5 millimeters in length, with many setæ scarcely or slightly curved. Head nearly straight on the front, divided, short, with many setæ, which are somewhat curved and much shorter than the first antennal joint. Antennæ slender, about 1.9 millimeters in length, with many rather stiff setæ as long as those on the head;

[1] Dept. Agr., Govt. Res. Inst. Formosa, Rept. 53.

first joint as long as the second; third as long as the fourth, fifth and sixth taken together, with 1 to 6 small circular sensoria in a row on the distal part; fourth with 2 to 4 similar sensoria; fifth slightly imbricated on the distal part, with a large circular sensorium; the relative length of joints about as follows: III—48, IV—17, V—20, VI—10. Eyes with small ocular tubercles. Rostrum reaching a little beyond the hind coxæ. Abdomen distinctly reticulated, with a large median rounded conical tubercle. Cornicles on large hairy cones. Cauda short, very broadly rounded, with many long hairs. Legs very long, covered with many stout setæ; hind tibiæ somewhat curved, tapering, much stouter than the antenna, about 4 millimeters in length; hind tarsi nearly as long as the fourth antennal joint.

Host.—*Quercus glauca,* attacking the shoot.

Habitat.—Shinten near Taihoku.

A few apterous forms were taken by me June 14, 1931. Differs from other species of the genus *Lachnus* (synonym *Pterochlorus* Baker) in the black legs, and is also characterized by the reticulated abdomen. The Japanese species recorded by me as *Pterochlorus roboris* Linn.[2] is different from the present species in the larger body and in possessing some small dusky patches on the abdomen.

CERATOVACUNA ARUNDINARIÆ sp. nov.

Wingless viviparous female.—Yellow, densely provided with short white wax secretion. Body oval, moderately convex on the dorsum, about 1.8 or 1.9 millimeters in length, with many groups of very large well-developed wax pores on the whole dorsum and sides; the pores chitinized on the margin, protruding, oval, subcircular, or triangular with rounded corners, separated, nearly subequal in size, with minute polygonal markings, those on the eighth abdominal segment sometimes a little smaller. Dorsum somewhat chitinized on the areas of wax pores, without not-well-developed wax pores. Head and pronotum fused together, with some rather long fine hairs and areolations. Horns conical, pointed apically, expanded basally, stout, longer than wide, nearly as long as the first antennal joint, slightly diverging, somewhat curved upward, often with a slight constriction near the base, with a few short setæ. Eyes of three facets. Antennæ short, 4 jointed, about 0.25 millimeter long, with a few setæ; third joint expanded towards the distal end, with a circular sensorium as large as the facet of eye;

[2] Aphididæ of Formosa, pt. 3, 115.

fourth joint a little shorter than the third. Rostrum reaching the middle coxæ. Thorax and abdomen with a few rather long, fine hairs. Cornicles very short, dusky, striate, nearly as large in diameter as the wax pore at the distal end, not on hairy cones. Cauda constricted at the base, wide, wider than the lobe of anal plate, with some bristles, of which two on the hind margin are longer. Anal plate bilobed, with some long bristles. Legs with some rather long fine hairs; front tibiæ nearly as long as the antenna; hind tibiæ about 0.4 millimeter long; hind tarsi nearly as long as or longer than the third antennal joint.

Host.—*Arundinaria* sp., attacking the lower side, especially the basal part, of leaf.

Habitat.—Taihezan (altitude about 5,500 feet).

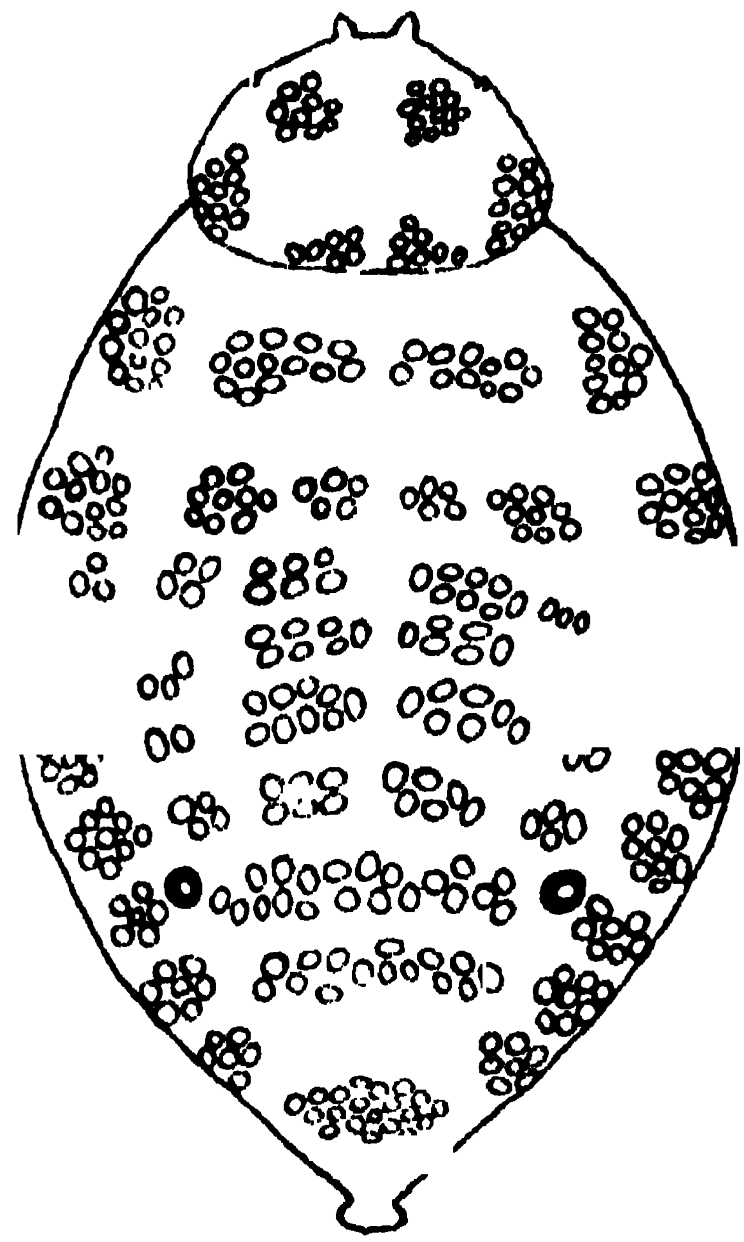

FIG. 1. *Ceratovacuna arundinariæ* sp. nov., adult female.

Observed in abundance May 21, 1931. This species is allied to *Ceratovacuna silvestrii* Takahashi described from Yunnan, China, but is different from it in the shape of the frontal horns, as well as in the characters of the wax pores.

TRICHOREGMA NIPAE van der Goot.

Oregma nipae VAN DER GOOT, Contr. Fauna Indes Neerl. 1, 3 (1917) 208.

Host.—*Languas* sp. (Zingiberaceæ), attacking the lower side of leaf.

Habitat.—Urai.

Some apterous forms were taken by me September 6, 1931. Previously unknown from Formosa. The cornicles are on elevated cones which are provided with 6 or 7 long bristles, and the species is included in *Trichoregma* Takahashi. The Formosan specimens differ from the original description in that the horns are slightly shorter and the antennæ 4-jointed. In *Trichoregma* and the allied genera the antennæ are variable in the number of joints in the apterous form and the horns are also sometimes variable in length, and the above differences should not be

specific, and now I adopt this name for the Formosan species on *Languas*.

THORACAPHIS SETIGERUS sp. nov.

Wingless viviparous female.—Black, with no secretion. Body elongate, oval, flattened, somewhat indented on the front margin, strongly chitinized, about 0.55 to 0.6 millimeter long, with about 5 very slight indentations on the side and 34 short stout spinelike submarginal setæ in a row along the whole margin; the setæ sharply pointed, slightly swollen about the middle, subequal in length, somewhat or not reaching beyond the body margin. Dorsum distinctly reticulated, without setæ. Head and thorax entirely fused together, occupying most of the body. Eyes of 3 facets. Antennæ and legs small, concealed under the body. Abdomen very small, not well defined from the thorax, but the eighth segment distinctly defined, rounded on the hind margin, with 4 setæ. Cornicles not discernible. Cauda and anal plate concealed; the former very small, wider than long, very slightly constricted basally; the latter divided.

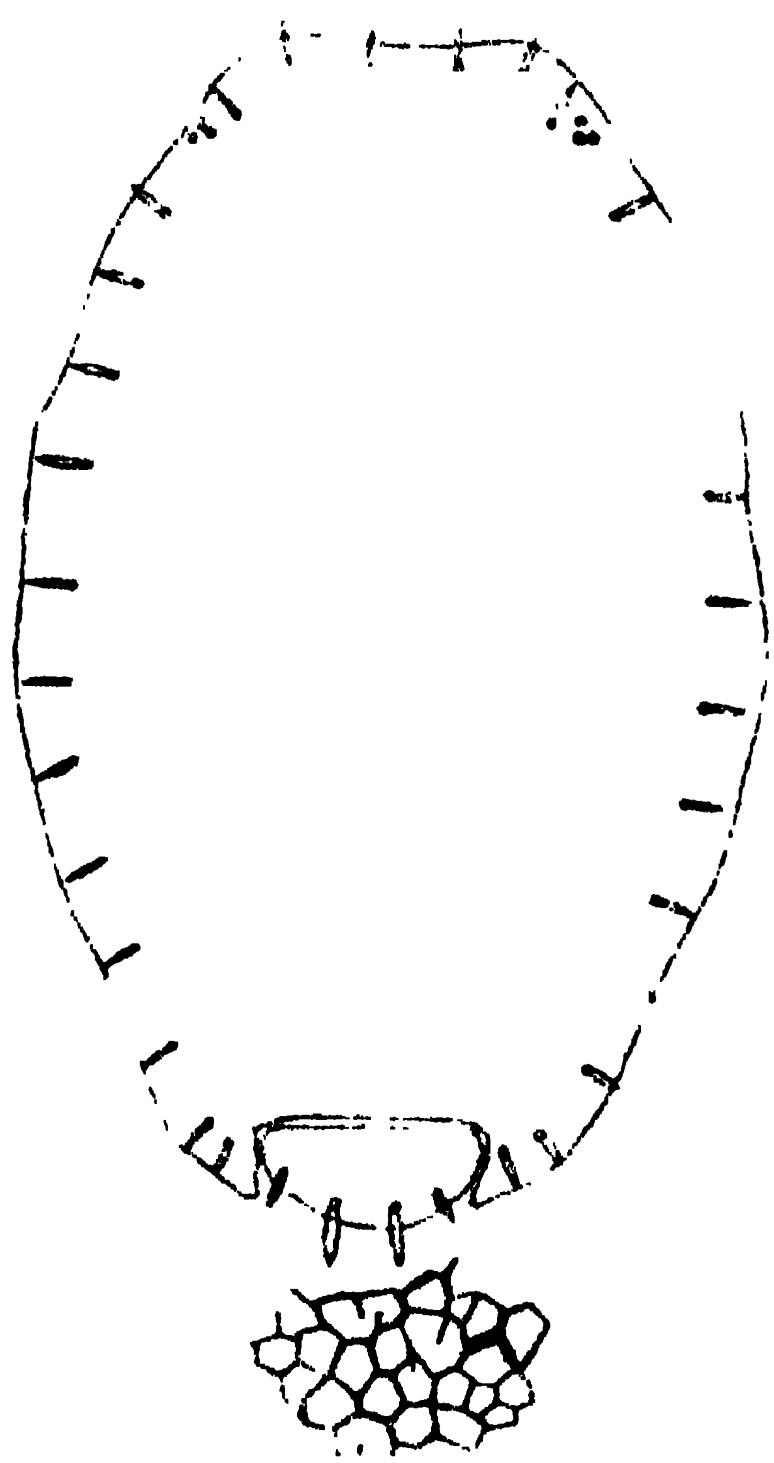

FIG. 2. *Thoracaphis setigerus* sp. nov., adult female and its dorsal reticulations.

Host.—*Quercus glauca*, attacking the lower side of leaf.

Habitat.—Urai, Shinten, Taihoku.

Many specimens were collected by me September 6, 1931. This species is characterized by possessing stout setæ along the margin of body, which is reticulated dorsally. The apterous forms are in very loose clusters. This form may be the aleyrodiform female of *Astegopteryx*.

THORACAPHIS KASHIFOLIÆ Uye.

Astegopteryx kashifoliæ UYE, Insect World, Gifu 28 (1924) 14.

Host.—*Quercus glauca*, attacking the upper side of leaf.

Habitat.—Shinten.

Many apterous females were collected by me June 14, 1931. Previously known only from Japan. The aleyrodiform female is wanting in reticulations and is not granular on the dorsum, but the cephalothorax is provided with 2 longitudinal furrows, which are somewhat diverging anteriorly and are connected by a transverse furrow on the hind ends, and with a short median furrow between the transverse furrow and the posterior margin of thorax.

FORDA FOLLICULARIA Pass.

Atti Soc. Ital. Sci. Nat. 3 (1861) 400.

Host.—*Paspalum* sp. (Gramineæ), attacking the root.

Habitat.—Kori.

New to the fauna of Formosa. Dr. A. Mordvilko has kindly compared the Formosan specimens with the European and Siberian ones, and writes me that the Formosan apterous forms have longer hairs on the body.

ILLUSTRATIONS

TEXT FIGURES

COMPOSITION OF PHILIPPINE SOY BEANS AND SOY-BEAN OIL

By AURELIO O. CRUZ and AUGUSTUS P. WEST

Of the Bureau of Science, Manila

Soy beans have been grown for many years in China, Korea, Japan, Formosa, and Indo-China. In recent years enormous quantities have been produced in Manchuria and exported to Europe. The beans are now also raised extensively in the United States. Some months ago we obtained a supply of soy beans raised in the Philippines. Our analyses of the Philippine soy beans and soy-bean oil showed that these products are very similar in composition to the soy beans and oil produced in other countries.

On account of their highly nutritive properties and protein content the addition of soy beans to the usual diet of Filipinos should be very desirable especially in outlying districts where meat is rather scarce and the food consists mostly of rice which is deficient in proteins and fats. The cultivation of soy beans in the Philippines would seem to offer promising prospects as a profitable and also very desirable industry.

During the past twenty years more than a thousand varieties of soy beans have been introduced into the United States from Far Eastern countries.[1] It seems that the bean can be grown successfully in any climate suitable for corn or cotton. However, experience has shown that some varieties do not grow so well in certain localities and, accordingly, a definite variety should be selected, by experimental growing, for each locality. Records of soy beans imported into the United States from China indicate that most Chinese villages have their own distinct varieties.

Soy beans grow well in combination with other farm crops. They also do well when grown in rotation with rice[2] and consequently make a very suitable crop for a country where rice is one of the principal agricultural industries. Like most other

[1] Year Book, U. S. Dept. Agr. (1926) 678.

[2] Year Book, U. S. Dept. Agr. (1926) 673.

legumes soy beans are able to utilize the nitrogen of the air through the action of bacteria that live on the roots and develop nodules or tubercles.

Soy beans may become infected with various leaf diseases which are manifest primarily in the form of leaf spots.[3] These may be controlled, however, by suitable methods.

Soy-bean oil is used largely in the manufacture of soaps, paints, varnishes, linoleum, enamels, lubricating oils, printing inks, waterproof goods, salad oils, and substitutes for rubber, lard, and butter. The oil cake remaining after the oil is extracted from the bean is a highly concentrated and nutritious food and is not only relished by all kinds of livestock but is also suitable for human consumption.

Soy-bean cultivation is not only profitable for the production of a commercially useful oil but also for various other purposes such as making hay, silage, and pasturage. During the last few years the number of companies in the United States manufacturing special soy-bean products has increased considerably. Soy beans are now made into breakfast foods, crackers, wafers, soy sauce, bean curd, and soy flour. Recipes for making soy-bean preparations are given in various publications.[4] Miss Maria Y. Orosa, of the Bureau of Science, has made excellent cakes, cookies, puddings, sauces, soups, custards, ice cream, and other tasty preparations from Philippine soy beans.

The nutritional value of soy beans depends upon the fact that they contain about 20 per cent of edible oil and have a very high protein content ranging from about 30 to 40 per cent. The protein of soy beans, unlike that of other vegetables, is similar to animal proteins and seems to fulfill all physiologic requirements.[5] Soy-bean protein appears to be quite as valuable as the casein of milk. These conclusions are based upon actual feeding experiments and not merely upon food values calculated from chemical analyses as the latter cannot be considered an adequate method for determining the nutritive efficiency of a given food. A food may have a high protein content and yet

[3] Lehman, S. G., Journ. Agr. Research 36 (1928) 811. Piper, C. V., and W. J. Morse, The Soy Bean (1923) 280.

[4] Piper, C. V., and W. J. Morse, The Soy Bean (1923) 259. Orosa, M. Y., Soy beans as a component of a balanced diet and how to prepare them, Bur. Sci. Pop. Bull. 13 (1932).

[5] Daniels, A. L., and N. B. Nichols, Journ. Biol. Chem. 32 (1917) 95. Osborne, T. B., and L. B. Mendel, Journ. Biol. Chem. 32 (1917) 375.

only a portion of the amino acids obtained from these proteins may have a highly nutritional value. According to Osborne and Campbell [6] the chief protein of soy bean is a globulin, glycinin. When hydrolyzed this protein yields amino acids comparable to those of cow's milk and the proportion of amino acids is not very different from that found in animal flesh.

Soy beans contain only traces of starch and so flours made from soy beans are naturally a valuable addition to the dietary of diabetics. The protein of soy flour, when thoroughly cooked, is about 91 per cent digestible and the carbohydrates about 94 per cent.

Milk made from soy beans is quite comparable to animal milk and has similar properties. Soy milk is used extensively throughout China for infant feeding. Soy milk has been found to be very useful in cases of summer diarrhœa and other intestinal disorders where human or cow's milk was not well tolerated.[7]

In addition to their high protein content, soy beans are also exceptionally nutritious in that they contain a fairly liberal supply of both the water-soluble and fat-soluble vitamins.[8]

Experiments carried out by Daniels and McClung [9] have shown that in cooking soy beans at a temperature of 120° or with an excess of sodium bicarbonate there was no great destruction of the antineuritic vitamin.

An excellent account and bibliography of the soy bean is given by Piper and Morse.[10]

Soy beans in the Philippines.—Just when soy-bean cultivation was first started in the Philippines is not known. For years casual plantings have been made but it is only in recent years that the cultivation has been seriously considered as an agricultural industry. Two of the most widely used foods manufactured from soy beans are soy-bean curd and soy sauce, known in the Philippines as "toyo." The Chinese have introduced and extended the use of these products throughout the

[6] Osborne, T. B., and S. F. Campbell, Conn. Agr. Exp. Sta. Rep. 21 (1897) 374.

[7] Muggia, A., and E. Gasca, Gazz. Ospedali Clin. 42 (1921) 356.

[8] Daniels, A. L., and N. B. Nichols, Journ. Biol. Chem. 32 (1917) 96. Osborne, T. B., and L. B. Mendel, Journ. Biol. Chem. 32 (1917) 376.

[9] Journ. Biol. Chem. 37 (1919) 201.

[10] The Soy Bean, McGraw-Hill Co. (1923).

East. For years both of these preparations have been made by Chinese in the Philippines.

The first investigation carried out in the Philippines on the nutritive value of soy beans was made in 1912 by Gibbs and Agcaoili [11] of the Bureau of Science. They analyzed the soy-bean curd made in the Philippines and described briefly the local method of manufacture. They also pointed out the fact that soy beans serve as an important nitrogenous food in countries like China and Japan where rice is the principal article of diet and stated that the employment of this food was rapidly extending and its value becoming appreciated in other countries. They also mentioned the fact that large quantities were being imported into the Philippines from southern China, principally from Amoy and Hongkong. In a paper published a few months later Gibbs, Agcaoili, and Shilling [12] gave analyses of Philippine soy (toyo) sauce and also notes on the local manufacture of this product, which is a Chinese sauce of the Worcestershire type. A more-detailed account of the manufacture of soy sauce as prepared in the Philippines is given by Salazar.[13] Groff [14] gives an excellent description of the process as practiced in Canton, China.

An investigation of the nitrogen content of soy beans imported into the Philippines was made by Brill and Alincastre [15] of the Bureau of Science in 1917. Field tests on the growing of soy beans in the Philippines have been carried out by Layosa [16] who mentioned the fact that soy beans are used in China, Japan, and other countries as a substitute for meat. Experiments on seed selection for Philippine cultivation have been made by Maceda.[17] Prominent among others who have written technical articles suggesting the advisability of growing soy beans in the Philippines for their nutritive value may be mentioned Barrett,[18] Wester,[19] and Mendiola.[20]

[11] Philip. Journ. Sci. § A 7 (1912) 47.

[12] Philip. Journ. Sci. § A 7 (1912) 383.

[13] Philip. Agr. 15 (1926) 219.

[14] Philip. Journ. Sci. 15 (1919) 307.

[15] Philip. Journ. Sci. § A 12 (1917) 127.

[16] Philip. Agr. and For. 6 (1918) 276.

[17] Philip. Agr. and For. 8 (1919) 92.

[18] Philip. Agr. Rev. 4 (1911) 594; 6 (1913) 348.

[19] The Food Plants of the Philippines, Philip. Bur. Agr. Bull. 39 (1925) 180.

[20] A Manual of Plant Breeding for the Tropics (1926) 230.

During recent years soy beans have been grown to a limited extent in the Philippines. According to Doctor Roxas, director of the Bureau of Plant Industry, 4,218 tons were produced in 1930.

In 1911 Barrett,[21] of the Philippine Bureau of Agriculture, wrote as follows:

> Now is the time for the Philippine Agriculturist to take up soy bean culture in earnest, and to develop it in the same way, even if not to the same degree, as our neighbors across the way have been doing for centuries.

Twenty years after this advice was given we find the Philippines are producing an annual yield of only a few thousand tons of soy beans although, as shown by experiments, this is a very suitable and appropriate crop for this country.

The diet of the Filipino masses consists largely of rice and is more or less deficient in fats, proteins, and vitamins, which are the principal nutritive constituents of soy beans. In order to familiarize the people with the food value of soy beans it would seem that some incentive, other than technical literature, is desirable to get the Filipinos really soy-bean minded. With this idea in view the Bureau of Science has recently taken steps to popularize the use of soy beans in the Philippines. Articles by members of the staff[22] have been published in the local papers. In these articles attention has again been called to the nutritive properties of the soy bean and the point particularly stressed was the suggestion to include soy beans as a regular part of the Filipino diet with the idea of supplying economically, to a considerable extent, the present deficiency. A ration consisting of about 20 per cent soy beans and 80 per cent rice has been suggested as a rather fairly balanced diet which should, of course, be supplemented by meat and fresh vegetables when convenient. At the recent Philippine carnival in Manila the division of food preservation of the Bureau of Science gave a display of food products made from soy beans. A bulletin[23] was also issued explaining how these foods may be prepared. During the coming year the Bureau of Science will send to the provinces, from the division of food preservation, assistants

[21] Philip. Agr. Rev. 4 (1911) 594.

[22] Brown, W. H., Philip. Tribune (Oct. 4, 1931). Brown, W. H., and A. J. Hermano, Philip. Herald (Oct. 24, 1931).

[23] Orosa, M. Y., Soy Beans as a Component of a Balanced Diet and how to prepare them, Bu. Science Pop. Bull. 13 (1932).

who will explain the value of soy beans as an addition to the usual Filipino diet and also demonstrate how to cook them. If we can popularize the use of soy beans and create a general demand for them agricultural development will naturally follow, with the result that the Filipinos will be better nourished on home-grown products.

EXPERIMENTAL PROCEDURE

The Philippine soy beans used in this investigation were grown at the College of Agriculture, Los Baños, and kindly presented to us by Dr. Nemesio B. Mendiola. The beans were ground to a fine powder and sieved to eliminate the coarser particles. The composition of Philippine soy beans compared with foreign soy beans and flour is given in Table 1.

TABLE 1.—*Composition of Philippine and foreign soy beans, straight grade flour, and soy-bean oil cake.*

Constituent.	Soy beans.		Straight grade flour.[b]	Philippine soy-bean oil cake.[c]
	Philippine.	Foreign.[a]		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	4.95	13.88	9.93	5.88
Fat	20.07	17.85	0.92	4.99
Protein	39.08	37.87	13.74	46.45
Ash	5.25	4.26	0.52	6.24
Crude fiber	5.69	6.30		6.77
Carbohydrates (by difference)	24.96	19.84	74.89	29.67
Total	100.00	100.00	100.00	100.00
Calories per kilo	4,492.00	4,026.00	3,719.00	3,585.00

[a] Average of four analyses of foreign soy beans, Holtz, E., Seifensieder Ztg. 56 (1929) 103, 112, 121, 130.

[b] Leach, A. E., and A. L. Winton, Food Inspection and Analysis (1920) 320, 322.

[c] Composition calculated.

As shown by the data the Philippine soy beans have a higher calculated food value than either the foreign beans or straight grade flour.

Soy-bean oil was prepared by extracting the ground seeds with ether. The oil was purified by treating successively with 2 per cent kieselguhr, suchar, and talcum powder. This treatment removes vegetable fibers and colloidal matter and produces a brilliantly clear dark yellow oil. The yield of oil is about 20 per cent.

The constants of this sample of Philippine soy-bean oil are given in Table 2.

TABLE 2.—*Physical and chemical constants of Philippine soy-bean oil.*

Specific gravity at $\frac{30^\circ}{4^\circ}$ C.	0.9153
Refractive index at 30° C.	1.4710
Iodine number (Hanus)	128.4
Saponification value	193.3
Unsaponifiable matter (per cent)	1.00
Acid value	1.5
Saturated acids, determined (per cent)	13.71
Unsaturated acids plus unsaponifiable matter, determined (per cent)	81.44
Saturated acids, corrected (per cent)	12.65
Unsaturated acids, corrected (per cent)	81.50
Iodine number of unsaturated acids	151.3

The saturated and unsaturated acids that occur as glycerides in Philippine soy-bean oil were separated by the lead-salt-ether method [24] in accordance with the suggestions of Baughman and Jamieson.[25] The results are recorded in Table 3.

TABLE 3.—*Separation of saturated acids from the unsaturated acids in Philippine soy-bean oil by the lead-salt-ether method.*

Experiment No.—	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids (determined).	Saturated acids (determined).	Unsaturated acids (corrected).[a]	Saturated acids (corrected).
	g.	*g*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	12.0720	9.7831	1.7130	81.04	[b] 14.19	81.52	12.71
2	11.4586	9.3780	1.5147	81.84	[c] 13.22	81.47	12.59
Mean				81.44	13.71	81.50	12.65

[a] Unsaturated acids (unsaponifiable matter removed): Iodine number (Hanus), 151.3.
[b] Iodine number (Hanus), 15.8.
[c] Iodine number (Hanus), 7.2.

The unsaturated acids separated from soy-bean oil by the lead-salt-ether method were purified by removing the unsaponifiable matter in accordance with the procedure used for determining the unsaponifiable. The resulting soaps were acidified and converted again into the pure mixed unsaturated acids. These mixed acids were then treated with bromine and converted into their bromo-derivatives.[26] An ether-insoluble hexabrom-

[24] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.
[25] Cotton Oil Press 6 (1922) 41. Journ. Am. Chem. Soc. 42 (1920) 2398.
[26] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

ide was obtained thus showing the presence of linolenic acid. The precipitated hexabromide was washed with ether which was previously saturated with linolenic hexabromide and cooled to 0°. The hexabromide used in making the ether solution was prepared from raw linseed oil. The solubility of the hexabromide is decreased considerably by washing with a cold, ether solution saturated with hexabromide. From the weight of hexabromide obtained the percentage of linolenic acid corresponding to the hexabromide is then calculated. Knowing the percentage of linolenic acid (2.41) contained in the mixed unsaturated acids, the iodine number of these mixed acids (151.3), and also the iodine numbers of the individual unsaturated acids (linolenic, linolic, and oleic), the percentage of linolic and oleic acids contained in the mixture is readily calculated. The composition of the mixed unsaturated acids is given in Table 4. There are also included the calculated percentages of glycerides corresponding to these individual unsaturated acids.

TABLE 4.—*Percentage composition of the unsaturated acids of soy-bean oil and the glycerides corresponding to these acids.*

Acid.	Mixture of unsaturated acids.	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolenic	2.41	1.96	2.05
Linolic	62.21	50.70	52.98
Oleic	35.38	28.84	30.14
Total	100.00	81.50	85.17

Saturated acids.—The saturated acids were separated from soy-bean oil by the lead-salt-ether method and esterified with methyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours, after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal solution washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters, which were yellow, were distilled under diminished pressure. A preliminary distillation was

made, after which the esters were redistilled. Data on the distillation of the esters are given in Tables 5 and 6.

TABLE 5.—*First distillation of the methyl esters of the saturated acids; 112.5908 grams of esters distilled.*

Fraction.	Temperature.	Pressure.	Weight.
	°C.	mm.	g.
A	190-193	7.0	26.1210
B	193-198	6.5	31.9196
C	198-203	7.0	28.5868
D	203-211	7.0	15.6587
E	211-218	7.0	5.3657
Residue			4.73
Total			112.3758

TABLE 6.—*Second distillation of the methyl esters of the saturated acids; 112.3758 grams of esters redistilled.*

Fractions. From first distillation.	Fractions. Second distillation.	Temperature.	Pressure.	Weight.
		°C.	mm.	g.
A	1	190-192	5.5	16.6378
B	2	192	5.5	26.6660
C	3	192-197	5.5	18.2780
D and E	4	197-201	5.5	18.2498
Residue	5	201-204	5.0	14.3940
		204-215	5.0	10.7818
		215-238	5.0	5.4490
				1.78
Total				112.2364

In Table 7, are given the analyses of fractions obtained in the second distillation of methyl esters. From the data (Table 7), there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 8 and were calculated in accordance with the methods outlined by Baughman and Jamieson in their investigations of Hubbard squash-seed oil [27] and also American cottonseed oil.[28]

In Table 9 is given the composition of the mixed saturated acids and the glycerides in the original sample of soy-bean oil corresponding to these acids.

[27] Journ. Am. Chem. Soc. 42 (1920) 156.

[28] Journ. Am. Chem. Soc. 42 (1920) 1197.

TABLE 7.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*[a]

Fraction.	Iodine number.	Saponification value.	Mean molecular weight of mixed esters.	Composition of mixed esters.		Mean molecular weight of saturated esters.
				Saturated.	Unsaturated.	
				Per cent.	*Per cent.*	
1	6.22	206.6	271.5	95.68	4.32	270.6
2	6.92	203.9	275.1	95.20	4.80	274.2
3	9.90	202.8	276.6	93.13	6.87	275.4
4	15.91	199.2	281.6	88.96	11.04	280.1
5	21.90	195.4	287.1	84.80	15.20	285.8
6	26.94	190.0	295.3	81.30	18.70	295.4
7	20.81	180.1	311.5	85.56	14.44	314.5

[a] Calculated iodine number of unsaturated methyl esters was 144.1. Calculated saponification value of unsaturated methyl esters was 190.4.

TABLE 8.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction.	Acids.					
	Palmitic.		Stearic.		Arachidic.	
	Per cent.	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*
1	89.76	14.93	0.97	0.16		
2	77.70	20 72	12.64	3 37		
3	72.22	13.20	16.17	2.96		
4	54.82	10.00	29.68	5.42		
5	35.89	5.17	44.75	6.44		
6	7.98	0.86	69.46	7.49		
7			34.36	1.87	47.39	2.58
Residue[a]						1 70
Total		64.88		27.71		4.28

[a] Residue assumed to be methyl arachidate

TABLE 9.—*Saturated acids.*

Acid.	Mixture of saturated acids.			Glycerides in original oil.
	Weight.	Composition.	Proportion in original oil.	
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Palmitic	64.88	66.98	8.47	8.89
Stearic	27.71	28.60	3.62	3.78
Arachidic	4.28	4.42	0.56	0.58
Total	96.87	100.00	12.65	13.25

The composition of Philippine soy-bean oil is given in Table 10. There is also included for comparison the composition of a sample of soy-bean oil analyzed by Baughman and Jamieson.

As shown by the data the composition of Philippine soy-bean oil is very similar to that of the American oil.

TABLE 10.—*Composition of Philippine soy-bean oil compared with American soy-bean oil.*

Constituent.	Soy-bean oil. Philippine.	American.[a]
Glycerides:		
Unsaturated acids—		
Linolenic	2.1	2.3
Linolic	58.0	51.5
Oleic	30.1	33.4
Saturated acids		
Palmitic	8.9	6.8
Stearic	3.8	4.4
Arachidic	0.6	0.7
Lignoceric	....	0.1
Unsaponifiable matter	1.0	0.6
Total	99.5	99.8

[a] Composition determined by W. F. Baughman and J. S. Jamieson, Journ. Am. Chem. Soc. 44 (1922) 2947.

In Table 11 is given the composition of Philippine soy-bean oil compared with other oils. As shown by the data these oils have a somewhat similar composition and consist principally of a mixture of glycerides of linolic, oleic, and palmitic acids.

TABLE 11.—*Comparison of Philippine soy-bean oil with other oils.*

Constituent.	Philippine oils. Soy-bean oil.	Rice oil (hambas).[a]	Kapok-seed oil.[b]	Peanut oil.[c]	American cotton-seed oil.[d]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Glycerides of:					
Unsaturated acids—					
Linolenic	2.1	....	..	....	....
Linolic	58.0	27.7	29.3	27.0	41.7
Oleic	30.1	45.6	49.8	53.9	35.2
Saturated acids—					
Myristic	....	0.2	0.5	....	0.3
Palmitic	8.9	17.3	15.9	8.5	20.0
Stearic	3.8	1.8	2.3	3.6	2.0
Arachidic	0.6	0.7	0.8	3.4	0.6
Lignoceric	....	0.7	....	2.4	....
Unsaponifiable matter	1.0	4.0	0.8	0.3	....
Total	99.5	98.0	99.4	99.1	99.8

[a] Philippine rice oil (hambas), A. O. Cruz, A. P. West, and N. B. Mendiola, Philip. Journ. Sci. (in press).

[b] Philippine kapok-seed oil, A. O. Cruz and A. P. West, Philip. Journ. Sci. 46 (1931) 131.

[c] Philippine peanut oil, A. O. Cruz and A. P. West, Philip. Journ. Sci. 46 (1931) 199.

[d] American cottonseed oil, G. S. Jamieson and W. F. Baughman, Journ. Am. Chem. Soc. 42 (1920) 1197.

The determined iodine number of Philippine soy-bean oil was found to be 128.4 and the determined saponification value 193.3. The calculated iodine number is 123.3 and the saponification value 189.7. The iodine and saponification values calculated from the composition of the oil agree very closely with the determined values.

SUMMARY

Like the soy bean raised in other countries the Philippine soy beans are very nutritious on account of the fats, carbohydrates, and proteins which they contain.

The protein of soy beans, unlike that of other vegetables, is similar to animal proteins and seems to fulfill all physiologic requirements.

Delicious cakes, cookies, sauces, soups, milk, custard, ice cream, and other tasty preparations have been made from Philippine soy beans.

Philippine soy-bean oil consists principally of the glycerides of linolic, oleic, and palmitic acids. It also contains small quantities of linolenic, stearic, and arachidic acids.

In composition, Philippine soy-bean oil resembles rice oil, kapok-seed oil, peanut oil, and cottonseed oil in that all these oils consist principally of the glycerides of linolic, oleic, and palmitic acids, though in different proportions.

The diet of the Filipino masses consists largely of rice and is more or less deficient in fats, proteins, and vitamins, which are the principal nutritive constituents of soy beans. To supply the present deficiency it has been suggested to include soy beans as a regular part of the Filipino diet. A ration consisting of about 20 per cent soy beans and 80 per cent rice gives a fairly balanced diet which should, of course, be supplemented by meat and fresh vegetables when convenient.

STUDIES ON EXPERIMENTAL CREEPING ERUPTION IN THE PHILIPPINES [1]

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FIVE PLATES AND ONE TEXT FIGURE

In 1926, Kirby-Smith, Dove, and White(8) reported on the frequent occurrence in the South Atlantic and Gulf States of America of a type of creeping eruption caused by a larval nematode which, pending the discovery of the adult worm at the time, they named *Agamonematodum migrans*. Subsequently, Dove and White(3) succeeded in producing experimentally, a typical creeping eruption of the type that naturally occurs in those States, by the application of the third stage larvæ of *Ancylostoma braziliense* on the intact skin of human volunteers, and demonstrated beyond doubt, that the *Agamonematodum migrans* which they had previously found to be involved in the lesions of creeping eruption, is no other than the third stage larva of this dog and cat hookworm, which is a common parasite of these animals in those regions. Fulleborn(4) in 1927 also succeeded in producing experimentally a similar skin eruption by using the infective larvæ of the European dog hookworm, *Uncinaria stenocephala*. Attempts to produce creeping eruption in man with the third stage larvæ of *Ancylostoma caninum*, *Strongyloides*, and of certain other parasitic nematodes have been made, but so far the results have been negative. For some unknown reason the larvæ of *A. braziliense* and *U. stenocephala* tend to remain in the skin of man and therein make horizontal migrations, instead of promptly penetrating deeper and entering the blood vessels, as they do in hosts to which they are well adapted.

[1] Read in part before the joint meeting of the Philippine Society of Parasitologists and the Los Baños Biological Club at Tungkong Manga, Bulacan, October 3, 1931. The writer is indebted to Dr. Hilario Lara, acting director of the School of Hygiene and Public Health, for the deep interest he has shown in this investigation.

Ancylostoma braziliense is a very common parasite of cats in the Philippines. Schwartz(14) states that all the hookworms he examined in a collection from cats in this country were of this species. Philippine dogs also harbor this species of hookworm. Chandler(1) states that out of 480 hookworms recovered from Philippine dogs, 37 per cent were *A. braziliense.* Another reservoir host of this hookworm in this country is man. Manalang (Chandler, 1929) found over 11 per cent of 136 hospital cases infested with this species. According to Dove and White(3) creeping eruption occurs more frequently in the Southern United States during the summer months, especially after rainy weather. Children and persons who, by the nature of their occupation, have more contact with the soil are more liable to suffer from this skin affection. While there seems to be every reason to suspect that creeping eruption, of the type that has been found to be caused by the third stage larva of *A. braziliense* in the Southern United States, is also present in this country, it is rather strange that not a single case of this skin disease has so far been reported by our practitioners here. Dove and White(3) state that this creeping disease has been encountered rarely among the Negroes, suggesting a kind of racial resistance or immunity against the invasion of the skin by the larvæ of this worm. It should be recalled that this race also manifests a certain degree of resistance against human hookworm infestation. The question that is naturally raised, then, is: Is the apparent absence of creeping eruption in this country due to a natural resistance of the Filipino skin to the invasion of the third stage larva of *A. braziliense?* An attempt to answer this question forms the principal object of this investigation. Experimental infestations have been made on two human volunteers with the aim in view of producing typical lesions of creeping eruption by the application of the third stage larvæ of *A. braziliense* on intact skin. Incidentally, various other phases of this parasitic skin disease which have been observed in the course of this work will also be presented.

HISTORICAL

In order not to confuse the subject of this investigation with various other similar skin diseases known to be caused also by other metazoan parasites, a brief history of the origin of the term "creeping eruption" is deemed not out of place here. For decades, the term "creeping eruption" has been adopted by common usage to designate a group of skin affections which

have, as a common characteristic, a linear cutaneous eruption with an advancing end, believed to be caused by a migrating parasite. Among the first to use this term was Lee(10) who in 1874 encountered in England a skin disease characterized by an advancing linear lesion. Although he later encountered another case, he failed to find its cause; but from the nature of the eruption, he was led to believe that the "lesion was due to an active parasite or animalcule" migrating in the skin. At the second Dermatological Meeting in Vienna, Crocker(2) reported a similar case, but, also failing to find the causative organism, he expressed the belief that the creeping lesion was probably due to the "travels of some insect larva either in the epidermis or beneath it" and suggested the name "larva migrans" for the disease. Samson and Himmelstjerna(13) reported on a small "worm" which they found a number of times in the epidermis of the human skin, and which was later identified by Cholodkovsky, an entomologist, as larva of the horse botfly, *Gastrophilus*. Kane(7) described a similar case of skin eruption involving the larva of *Hypoderma bovis*. Similar reports from various parts of the world describing skin affections, which involved the migration in the skin of the larvæ of various species of flies, then followed in rapid succession. Naturally, as a result of these findings, creeping eruption was for a time generally considered as a myasis, until Leiper(11) in 1909, Tamura(15) in 1921, and Morishita(12) in 1924, incriminated *Gnathostoma siamense*, *Echinorhyncus sphærocephalus*, and *Gnathostoma hispidum*, respectively, (all of which are nematodes) as causative parasites also in the production of creeping eruption.

MATERIALS AND METHODS

The third-stage larvæ of *A. braziliense* that were used in the following infestation experiments were obtained by screening, with Baermann apparatus, and 8-day-old fæcal culture from a cat with a presumably pure infestation of this species of hookworm, as was subsequently shown by the examination of the worms which were recovered from the intestines at autopsy. Known numbers of the infective larvæ were incorporated in small amounts of sterile moist soil, and these were applied to the skin of the flexor surface of the arm for about twenty minutes. At the end of that time, the soil was wiped off and the infested area washed with saline solution. The arm was used so as to make observations on the progress of

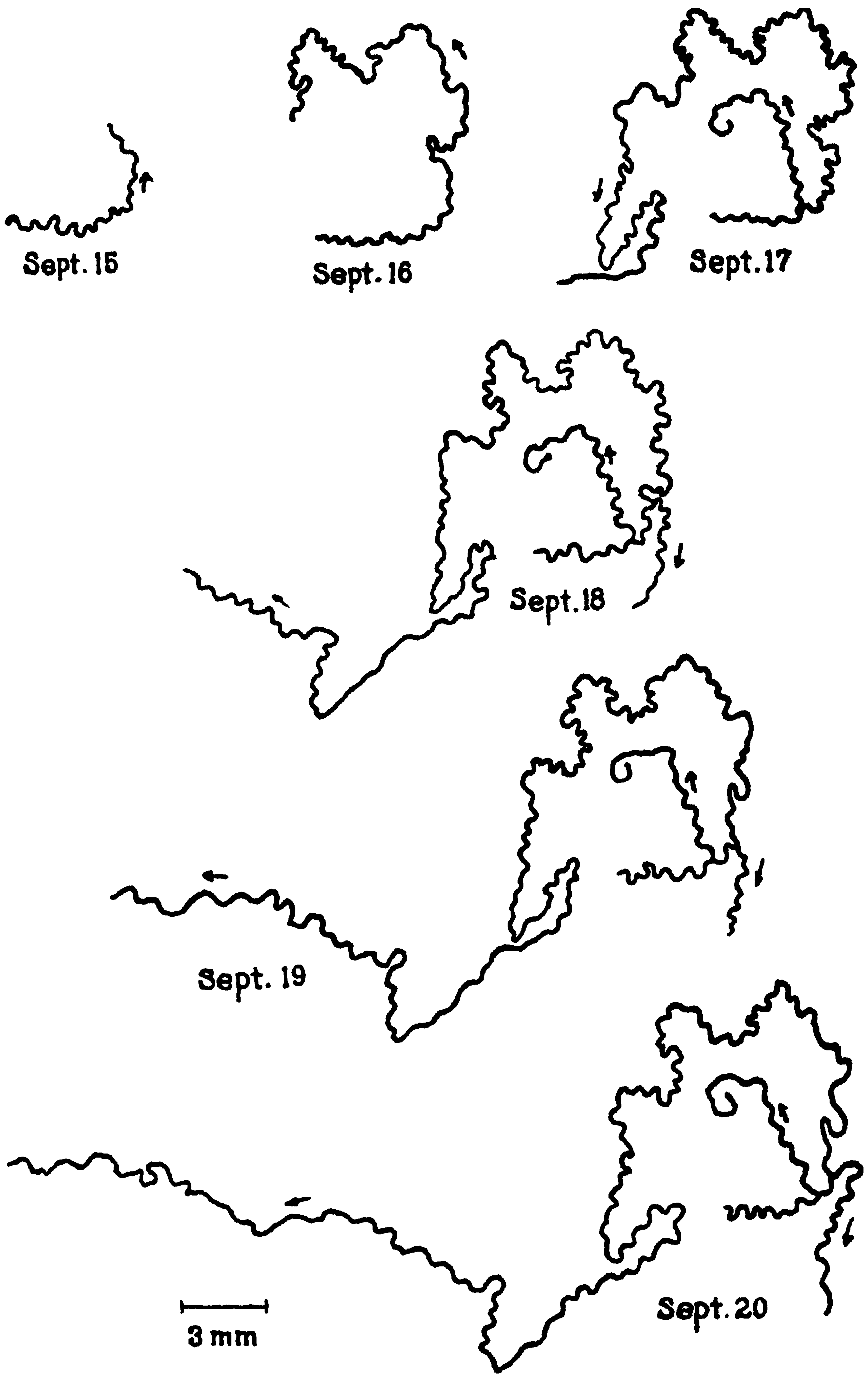

FIG. 1. Tracings of the trails made by the larvæ in the skin of volunteer 1, showing the progress of the migrating larvæ day by day. It is apparent that three larvæ were involved in the production of these linear eruptions.

the lesions easier or more convenient. As the writer was one of the two volunteers involved in these experimental infestations, it might be mentioned that the progress of the eruptions on his arm was subjected to an almost hourly subjective and objective observation.

Experiment 1.—C. M. A., the subject, was a male Filipino, 35 years old, without any previous hookworm infestation. Fæces consistently negative for hookworm eggs before the experiment. On September 4, 1931, fifty third-stage larvæ of *A. braziliense* were applied on the flexor surface of his arm. Typical lesions of creeping eruption were observed on the fifth day after the application of the larvæ. A week later, the eruptions developed to such an alarming proportion that it was decided to check their further advance by freezing them with ethyl chloride. The eruptions promptly disappeared after several applications of this remedy, but a few days afterwards, fresh linear eruptions suddenly flared up at the border of the original zone of infestation (fig. 5). Presumably these new eruptions were made by the few larvæ that escaped freezing, and which, after having lain dormant for a time, resumed their migratory activity. A daily tracing of these linear eruptions drawn to scale, was made for a period of six days in order to determine the rate of their progress (fig. 1). A few applications with ethyl chloride were enough to kill these left-overs so that by October 5, or a month after the application of the larvæ, the lesions had completely disappeared. It was apparent, however, that if left untreated, the eruptions would have spread and persisted for a considerable period. Stool still negative for hookworm eggs at this writing, October 30, 1931.

Experiment 2.—D. C. was a male Filipino, 19 years old, without any history of previous hookworm infestation. Fæces consistently negative for hookworm eggs before the experiment. Fifty third-stage larvæ of *A. braziliense* were applied on the skin of the flexor surface of his arm on September 4, 1931. The description of the course of the infestation in this case is closely parallel to that of case No. 1 described above, except for the fact that the volunteer afterwards developed a severe and extensive vesiculopustular dermatitis following bacterial infection due to scratching of the lesion. There was much swelling, redness, and pain of the parts involved, and for a time it was feared that he would develop an extensive cellulitis. Application of Dakin's solution alternated with freezing of the lesions

with ethyl chloride for about a week resulted in recovery. Stool still negative for hookworm eggs at this writing, October 30, 1931.

DESCRIPTION OF THE ERUPTIONS

A few minutes after the application of the infective material, a smarting, pricking sensation is felt. Ten minutes after the infective material is washed off, small wheals ranging in size from the head of a pin to almost microscopic elevations appear. Most of the initial lesions are congregated at the edge of the infested zone. It seems that the larvæ are especially active in penetrating the skin at this area. A few hours later reddish papules replace these initial wheals, these papules being at first discreet but later on the erythematous areolæ surrounding them coalesce, thus forming a confluent erythemato-papular eruption. At the end of twenty-four hours minute vesicles appear, the zone of infestations now becoming the seat of an erythemato-papulo-vesicular type of dermatitis. The itching at this stage is almost intolerable. Only a keen desire on the part of the writer to produce natural and typical lesions has prevented him from scratching them, and this required the exercise of a considerable amount of self-restraint, as the eruptions are what one might call exquisitely itchy. On the fifth day, definite linear, serpiginous, tortuous advancing eruptions begin to appear. New linear eruptions are usually noted early in the morning as faint streaks of erythema which, as the day advances, become definitely raised tortuous lines which fade very gradually towards the advancing end. In another twenty-four hours or so, the serpiginous lesions become punctuated with small pearly looking vesicles which yield a watery fluid on being punctured. These vesicles do not become pustular unless secondarily infected with bacteria. In another twenty-four hours the tail end of the advancing linear eruptions dries up, leaving a dark, collapsing linear crust, which marks the trail of the migrating larva. Scratching of the lesions may lead to a serious vesiculo-pustular type of dermatitis, which if unchecked may even involve deeper tissues and start a dangerous cellulitis.

HISTOPATHOLOGY

Biopsies have been performed at various intervals during the course of the infestation experiments. Stained sections have been studied and the positions assumed by the migrating larvæ

in the skin noted. Without exception, it has been noted that the larvæ are confined in the stratum mucosum. The larvæ are either tightly incarcerated or encapsulated by the proliferated epithelial cells (fig. 10), or lying loosely in tunnels (fig. 11), which have the stratum germinativum as the floor and the stratum granulosum or the stratum corneum as the roof. In the first instance, the epithelial cells surrounding the larva appear apparently normal, except those which are immediately in contact with the parasite, which show signs of cloudy swelling. It seems that the offending larva is well handled so that the toxic substance presumably excreted by the larva is well localized. On the other hand, the tissue reaction observed in the neighborhood of the larva, which occurs in tunnels, presents a different picture. Here œdema, marked cloudy swelling, and nuclear degeneration are noted. These are clear indications of certain toxic action exerted by the parasite on the surrounding tissue. That the larvæ of hookworms contain toxic substances is evidenced by the fact that "ground itch" has been produced experimentally by rubbing the skin with extracts of human hookworm larvæ (Chandler, 1930). Aside from round cell infiltration, regiments of eosinophiles are seen coming from under the corium in the direction of the offending parasite.

From the above study of the histopathology of the lesions of creeping eruption, it seems that the migrating larva is sometimes held in abeyance, or arrested in its migratory activity by the encapsulating power of the epithelial cells, and is therefore, unable to burrow its way to effect its advance. A struggle between the tissue cells and the parasite ensues, the body cells trying to imprison the parasite so as to localize its activity, while the larva throws out certain substances, or some kind of ferment with which it tries to dissolve or destroy the surrounding tissue. Sometimes the larva is successful and it breaks away from the clutches of the proliferated epithelial cells and starts burrowing tunnels in the stratum germinativum to effect migration. Sometimes the tissues are successful and the larva is kept in situ indefinitely until it dies and is calcified. This observation seems to find support in the fact that in the case of volunteer 1, new lines were noted to develop after periods of apparent inactivity on the part of the migrating larvæ. It seems quite likely that some of the larvæ in this case had been temporarily arrested in their activity by the tissue cells, and then succeeded in getting away.

DISCUSSION

The results of the above experiments tend to show that in so far as creeping eruption is concerned, the Filipino skin is just as susceptible to the invasion of the second stage larvæ of *A. braziliense* as that of the white population of the South Atlantic and the Gulf States of America, and that the explanation for the apparent absence of this skin disease in the Philippines must be sought in other directions. It is true that in the present work observations have been limited to the results of two experimental cases only. It may be asserted that no sweeping conclusions could be made with such limited data, but it is believed that such has been due, not to the difficulty in producing the lesions but rather to the lack of human volunteers. The ease with which typical lesions have been produced in the two cases involved in this work, gives ground for the belief that at least a large percentage of take could have been made if more volunteers were available. Indeed, it has been noted that the slightest carelessness in handling the infective material is enough to produce skin infestation with this larva. Considering the fact, however, that cats and dogs are popular pets in many Filipino homes, and that favorable climatic conditions for the proper development of the infective larval stages of *A. braziliense* are present throughout the year in this country, where sanitary facilities for the prevention of soil pollution are less adequate than in regions where this skin disease is frequently encountered, it is, indeed, rather surprising that not a single natural case of creeping eruption has so far been reported in this country.

A curious discrepancy which is of interest to mention, is that in Florida and its neighbor states where creeping eruption is frequently found, no human intestinal infestation of *A. braziliense* has so far been reported, whereas in the Philippines where human intestinal infestations with this species of hookworm have been rather frequently encountered, creeping eruption is apparently absent. This seems to suggest a duality of type of *A. braziliense*. It is possible that an Oriental type which has grown better adapted to the human host, and an occidental one, which is just in the first stage of adaptation, exist. In fact, from morphological grounds, Darling (1924) concludes that two definite types of this nematode exist; one which he calls the *ceylanicum* type, was first described as a distinct species under that name, and has been found in dogs, cats, and humans in India, Java, Malaya and the Philippines;

the other type occurs in South and Central America, and because it conforms better to the original description of the species described by de Faria, it is known as the *braziliense* type. It is quite possible that the cat and dog hookworms which cause creeping eruption in the Southern United States belong to the latter type. A study of the geographical distribution of the reported human infestations of *A. braziliense* seems to support this hypothesis.

The only report of human infestations of this worm from the western hemisphere is that of Gordon,(5) in which he recorded only 4 specimens of this worm out of 6,851 hookworms recovered from man in Amazonas, Brazil. On the other hand, human infestations of this worm have been reported many times in various countries of the Orient. In the Philippines Manalang (Chandler, 1929) found 11 per cent of 136 hospital cases infested with this worm, and found it to constitute about 1 per cent of 1,000 parasites obtained from Filipino inmates of a penal farm. Darling (1924) found 4 *A. braziliense* in 2,171 hookworms recovered from Malayans in the Malay Peninsula. In Burma, Jolly (Chandler, 1929) found 2.5 per cent of 7,629 hookworms recovered from man to be *A. braziliense*. Only 10 per cent of the Indian coolies who had been in Fiji for from two to ten years, harbored one or more hookworms of this species, with an average of 2.2 worms per infested man, whereas of 10 Indian coolies who had lived in Fiji for from 7 to 26 years, 31 per cent harbored *A. braziliense*, with an average of 4 worms per infested case (Chandler, 1929). Infection also occurs in India where Lane(9) found 20 specimens out of 2,625 hookworms as being of this species. In Rangoon Chandler(1) found 6 cases out of 7 autopsies harboring small numbers of ancylostomes (4 to 10) and no necators. Of the 6 infested individuals 5 harbored 2 or more *A. braziliense* and in one case 8 of the 10 worms were of this species. Chandler(1) states that "the presence of a heavy hookworm infestation is prima facie evidence of high susceptibility to hookworm infestation in general, which would probably be sufficient to allow an imperfectly adapted species to develop." This does not explain however, the relative absence of human infestations of this species of hookworm in the western hemisphere especially in the Southern United States where creeping eruption has been frequently reported, and where in certain areas the human hookworm burden of the population is just as heavy as in some Oriental countries.

In this connection it may be of interest to mention that a Japanese investigator after years of experimentation, seems to have succeeded in the establishing of human ascaris infestation in swine that had been kept on a vitamin-deficient diet for some time (Hall, 1930).(6) If it is true, as has been repeatedly alleged, that the rank and file of the Oriental population live on a vitamin-deficient diet, the apparent higher intestinal infestation among Orientals with *A. braziliense* might have been due to the existence of a better adapted type of this species of hookworm, which has been evolved in the course of time in this part of the world. This might also explain the frequent occurrence of creeping eruption caused by the larvæ of this worm in the southern United States and the apparent absence of the same in the Philippines and other Oriental countries. If the above conjecture is correct, it might be assumed that a great proportion of the larvæ, of the type better adapted to the general population of Oriental countries, promptly enter the circulation after penetrating the skin and develop into maturity in the intestine, as would the larvæ of the "normal" human hookworms, instead of staying in the skin and performing horizontal migrations that give rise to the typical lesions of creeping eruption. It is true that typical lesions of this skin disease have been produced in the two Filipino volunteers involved in this work, but they could hardly be classed among the vitamin-deficient portion of our population, as one is a physician and the other a well-nourished laboratory technician. It would be interesting to learn the results of similar infestation experiments in a larger series, performed on persons picked from the general population in the Philippines.

It seems quite probable, therefore, that other factors still unknown have a hand in the causation of this discrepancy in the geographical distribution of both the intestinal human infestations of *A. braziliense* and creeping eruption. This offers a fascinating field for students of host-parasite relations.

SUMMARY

Creeping eruption of the type found by Dove and White(3) to be due to the penetration of the skin by the third stage larvæ of *Ancylostoma braziliense* in the South Atlantic and the Gulf States of America, has been successfully produced experimentally on two Filipino volunteers with the infective larvæ of this species of hookworm, which heavily parasitizes cats, and to a certain extent dogs and humans in the Philippines. The apparent absence, therefore, of natural cases of creeping erup-

tion among the Filipinos cannot be explained on the ground of a racial resistance or immunity of the latter against the invasion of the skin by the larvæ of *A. braziliense*. The explanation for this must be sought in other directions.

The apparent discrepancy in the geographical distribution of creeping eruption and human intestinal infestations of *A. braziliense* seems to support Darling's contention that two distinct types of this species of hookworm exist; namely, an Oriental or a better-adapted type, and an Occidental type, which is just beginning to adapt itself to the human host. That a difference in the vitamin content of the diet of the two groups of people involved might have had something to do in the evolution of these two presumably distinct types of *A. braziliense*, seems probable.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Showing the initial lesions of creeping eruption photographed ten minutes after the application of the infective third-stage larvæ of *Ancylostoma braziliense* on the flexor surface of the arm of volunteer 1.

2. The infested zone on the arm of volunteer 1, twenty-four hours after the application of larvæ.

PLATE 2

FIG. 1. The same infested area forty-eight hours after the application of larvæ.

2. The same arm eighteen days after infestation, showing typical lesions of creeping eruption. X marks the original zone of infestation.

PLATE 3

FIG. 1. Creeping eruption on the arm of volunteer 2, photographed five days after the application of the third-stage larvæ.

2. The same arm of volunteer 2 on the seventh day after the application of the infective larvæ.

PLATE 4

FIG. 1. The same arm of volunteer 2 on the fourteenth day after infestation.

2. The arm of volunteer 2 developed a severe dermatitis following bacterial infection due to scratching. Photographed when the case was fairly well under control with Dakin's solution. Note that the characteristic linear eruptions have been effaced.

PLATE 5

FIG. 1. The infective third-stage larva of *Ancylostoma braziliense* from an 8-day fæcal culture from a cat.

2. Microphotograph of a section of the skin showing segments of the burrowing larvæ which are confined in the stratum germinativum. Note the flattening of the epithelial cells around the larva.

3. Cross section of a tunnel formed by the burrowing larva. Note the disintegrating larva just under the stratum corneum, the swollen epithelial cells with nuclear degeneration in the neighborhood of the parasite, and the stream of eosinophilic infiltration that comes from beneath the stratum Malphigi in the direction of the offending parasite.

TEXT FIGURE

FIG. 1. Tracings of the trails made by the larvæ in the skin of volunteer 1, showing the progress of the migrating larvæ day by day. It is apparent that three larvæ were involved in the production of these linear eruptions.

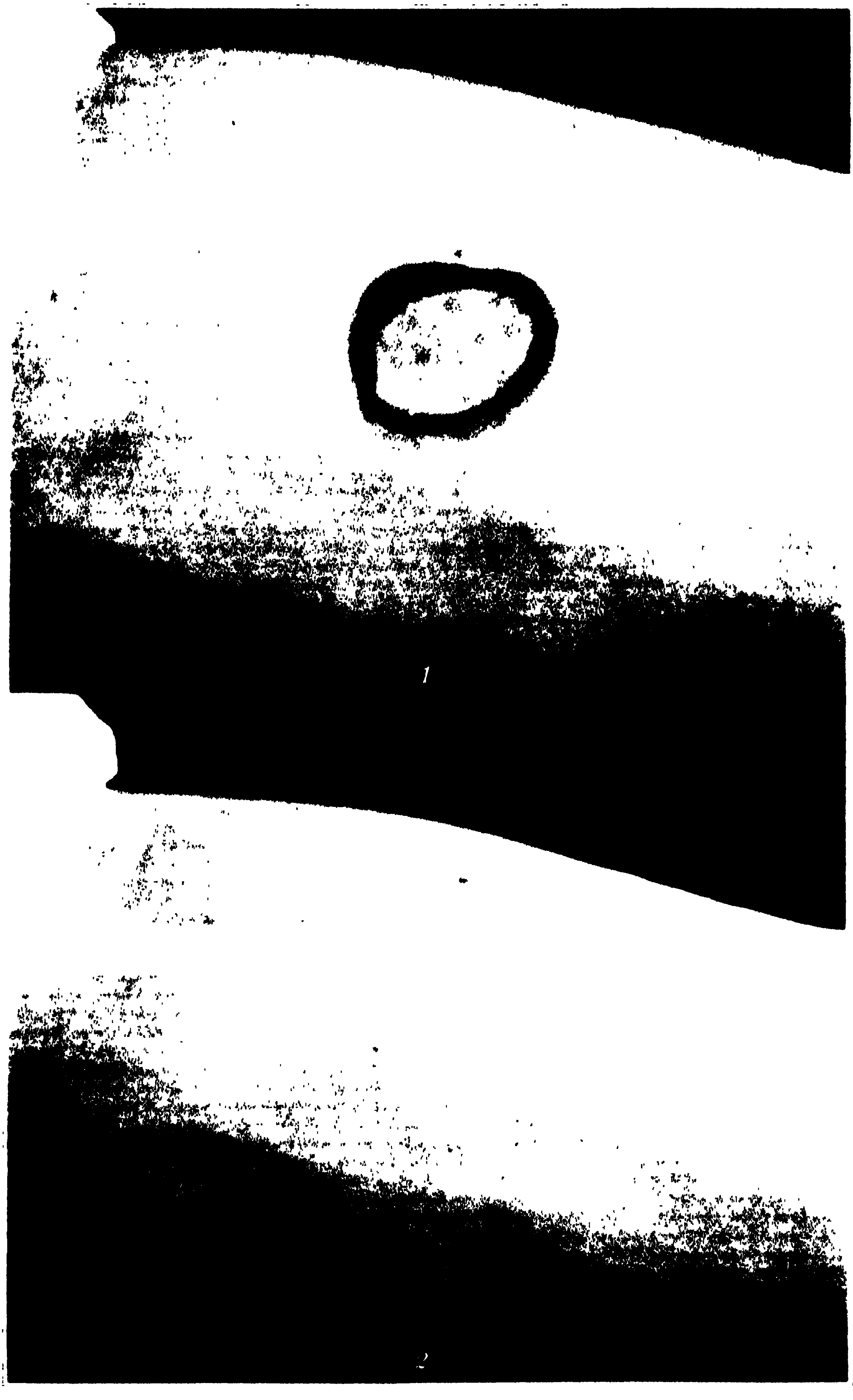

PLATE 1

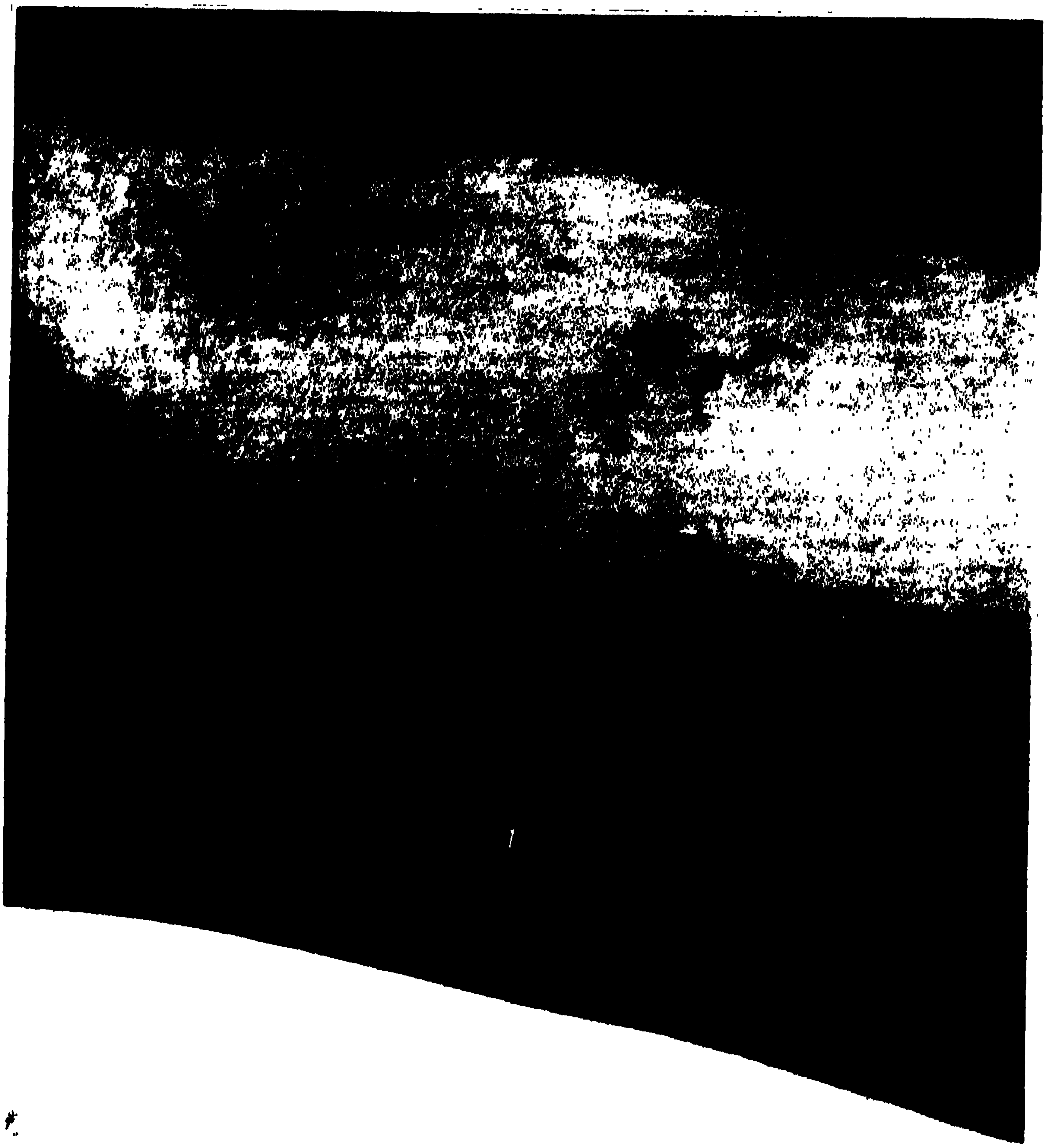

PLATE 2

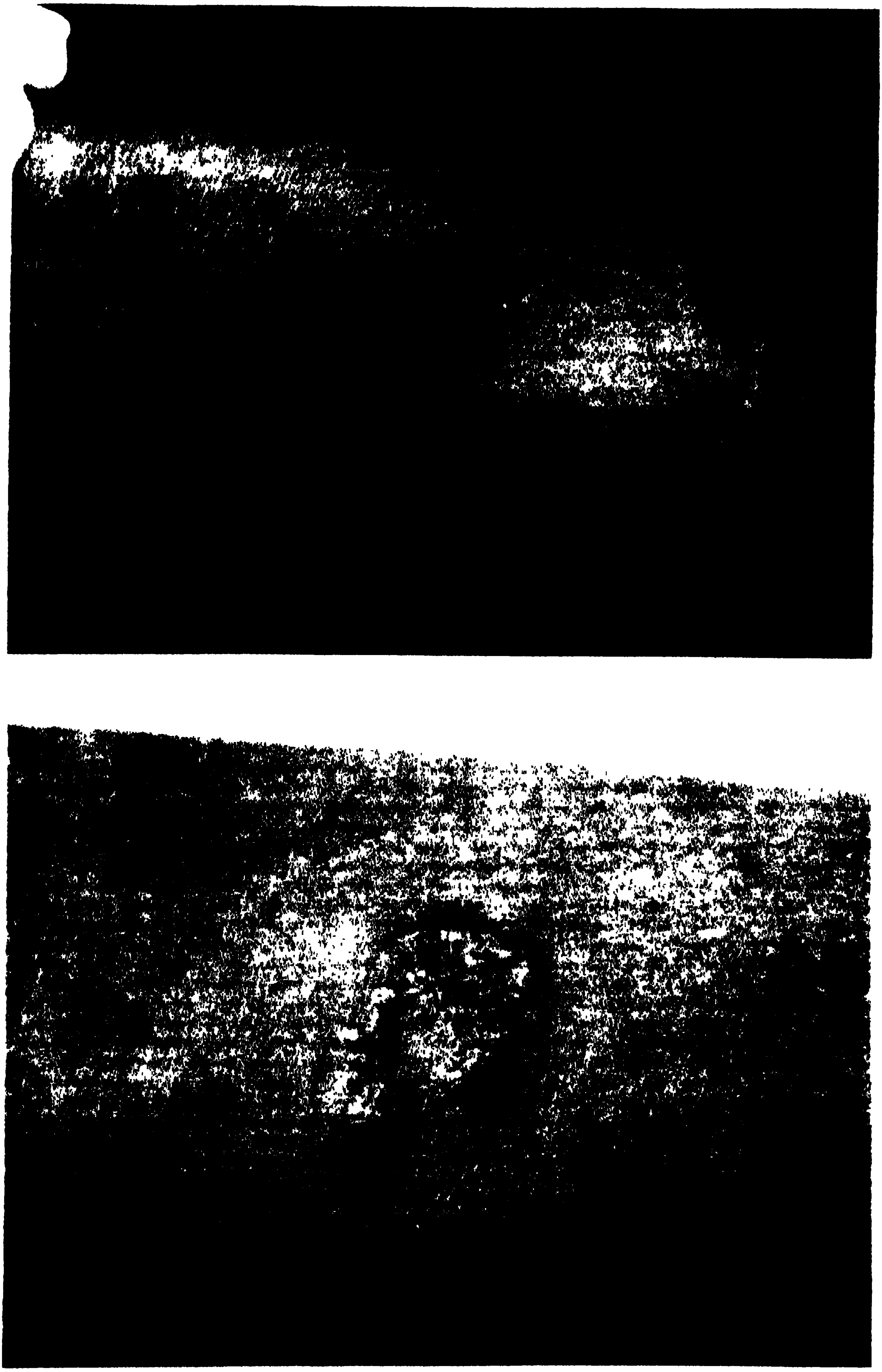

PLATE 3.

PLATE 4

STUDY ON A PHILIPPINE STRAIN OF LEPTOSPIRA ICTEROHÆMORRHAGIÆ [1]

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ONE TEXT FIGURE

INTRODUCTION

The absence of infectious jaundice (Weil's disease) from the Philippine Islands has frequently been remarked upon. McKinley [3] remarks—

> In so far as we have been able to learn, epidemics of so-called infectious jaundice have never occurred in the Philippines. Indeed the writer has been unable to find any record in the various hospitals in Manila or in the Naval Hospital at Cañacao of a single case of infectious jaundice associated with the presence of the *Leptospira icterohæmorrhagiæ*. This is a curious observation in view of the widespread prevalence of this disease in Japan and Formosa and the extensive shipping communications which exist between these countries and the Philippines.
>
> * * * * * * *
>
> In rat series 192 to 197 the pooled blood contained spirochetes and guinea pigs receiving 5 cubic centimeters of blood intraperitoneally from this series of rats developed typical jaundice and cultures of *Leptospira icterohæmorrhagiæ* were obtained from the kidneys of the dead guinea pigs. Healthy guinea pigs inoculated with kidney emulsion of these animals developed jaundice. The cultures from the original guinea pigs unfortunately became contaminated and were lost. We were never able to use these cultures for experimental infections and did not attempt to isolate others since we were interested solely in determining the presence of the parasite. Subsequent examination of over 50 rats has never resulted in another positive result. None of the kidney sections have shown spirochetes. From the morphological, pathological and cultural characteristics of these spirochetes we feel certain that they are *Leptospira icterohæmorrhagiæ*.

In addition to the evidence produced by McKinley which shows that infection with *Leptospira icterohæmorrhagiæ* exists among

[1] Received for publication November, 1931.
[2] Lieutenant Colonel, Imperial Japanese Army.
[3] Proc. Soc. Exp. Biol. & Med. 26 (1928–29) 26–28.

rats in Manila, we are presenting herewith further proof of the presence in the Philippines of Weil's disease as a contribution to the nosography of this disease. The study of the Manila strain of *Leptospira icterohæmorrhagiæ*, as presented in this publication, leaves no doubt of the identity of the parasite. It shows the possibility of the disease being contracted by man and the biologic peculiarity of the Manila strain may explain the paucity of the disease among humans as well as among rats in Manila.

THE SOURCE OF MATERIAL

A Japanese, residing continuously in Manila for three years, suddenly became ill. According to the relatives of the patient the illness commenced with vomiting and fever. These symptoms soon were joined by jaundice and anuria, according to the statement of the patient's relatives. The patient was removed to a local hospital where he died. Due to the advanced stage of the disease only urine was secured for laboratory examination, and investigation was carried out by laboratory experiments in search of *Leptospira icterohæmorrhagiæ*.

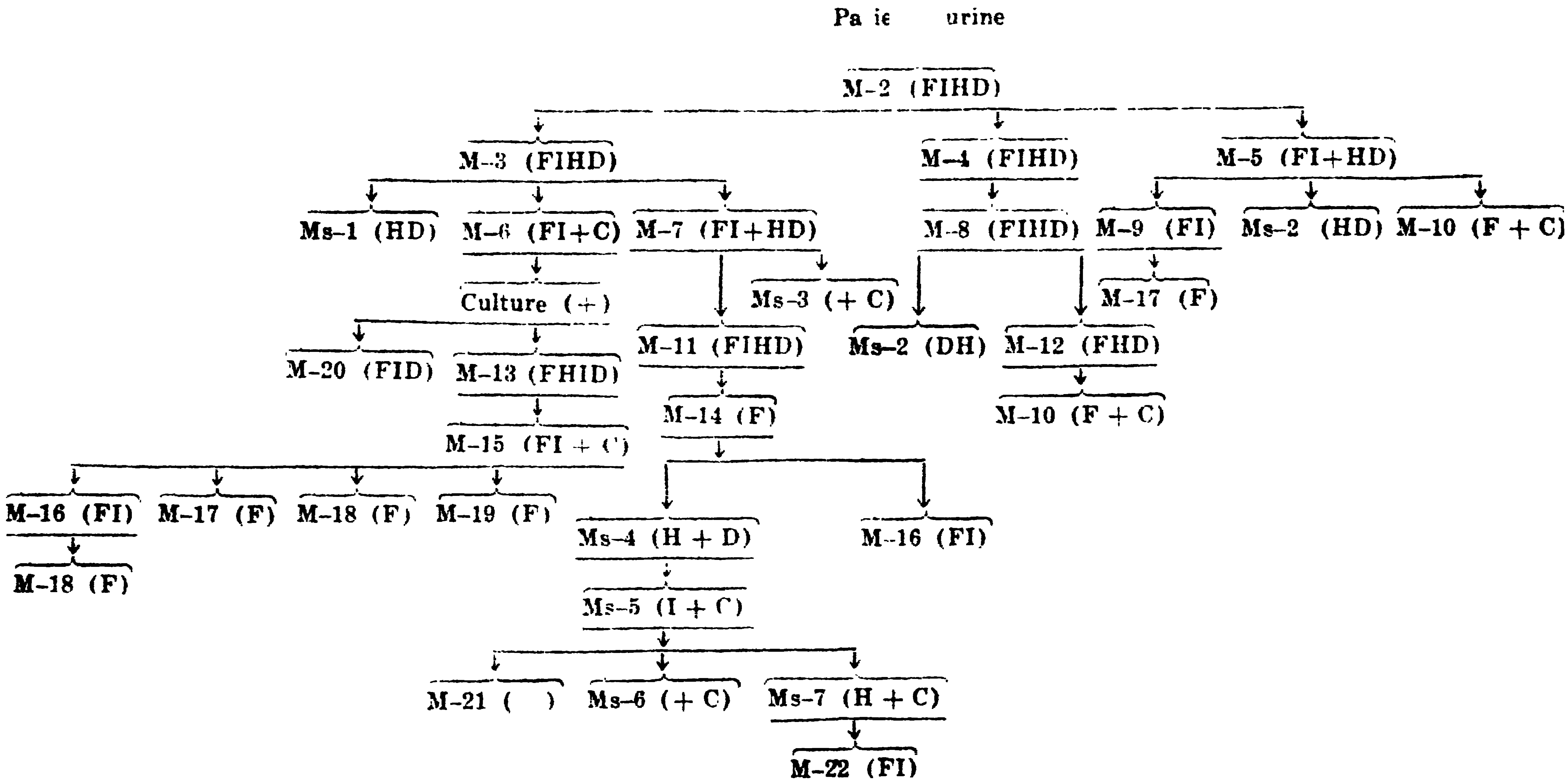
PROCEDURE OF EXPERIMENTAL INVESTIGATION

About 8 cubic centimeters of the patient's urine was centrifuged and the resulting sediment together with 2 cubic centimeters of the supernatant fluid was injected subcutaneously into a guinea pig weighing 130 grams. Microscopic dark-field examination of the urine sediment failed to reveal spirochætes. The inoculated guinea pig developed considerable swelling at the point of inoculation. The swelling gradually localized and an abscess formed at the place of inoculation. The pus obtained from the abscess was examined under the dark-field microscope, but no spirochætes were found. There was distinct jaundice discolorization noticeable around the abscess and a slight general icterus.

At this time, thirteen days after inoculation, about 0.2 cubic centimeter of this animal's blood was withdrawn and injected intraperitoneally into a normal guinea pig. The next day; that is, the fourteenth day after inoculation the first guinea pig that was inoculated with the patient's urine died. During the last few days of sickness, the animal showed moderate fever. Autopsy performed on the inoculated animal showed typical findings of experimental Weil's disease. Further passages through guinea pigs are given in Table 1.

TABLE —*Showing ti uccess ssages 'an 'r of Leptospira icterohæmorrhag*

Ms, white mou D, died: rier; F is hæmorrhages; +, leptospiræ found b) 'kfiel



ANIMAL INOCULATION

Subsequent inoculations of experimental animals were performed by intraperitoneal injection. The experimental animals used were guinea pigs and white mice.

CULTIVATION OF THE PHILIPPINE STRAIN OF LEPTOSPIRA ICTEROHÆMORRHAGIÆ

The culture medium employed in cultivation was Ohba's medium, consisting of tap water that contained 0.1 per cent calcium chloride.

The inoculum was blood obtained from living guinea pigs showing symptoms of the infection. The inoculated culture media were incubated at a temperature of 36.5° C. under aërobic conditions.

The identity of the spirochætes obtained in the culture with *Leptospira icterohæmorrhagiæ* was proven by dark-field, stained smears, and Levaditi sections. Both guinea pigs inoculated with the culture died with typical symptoms and autopsy findings.

MORPHOLOGY AND CULTURAL CHARACTERISTICS

In its morphology, as observed in material obtained from inoculated animals and from cultures, the parasite was identical with those strains observed by the author on many occasions in Japan.

The morphology of the parasites in question was studied in direct slides obtained from organs at autopsy, in blood and urine during life. Aside from dark-field examination, smears were prepared from the above-mentioned materials and stained by Fontana's method, carbol fuchsin, carbol gentian violet, and Giemsa stain. Sections were stained by the Levaditi method.

CLINICAL PICTURE OF EXPERIMENTAL INFECTION WITH MANILA STRAIN OF LEPTOSPIRA ICTEROHÆMORRHAGIÆ IN GUINEA PIGS

The clinically noticeable signs of experimental Weil's disease are fever and jaundice. Mortality is high among inoculated guinea pigs.

A few days after the inoculation, the body temperature rises, and reaches the highest point from the fifth to the eighth day after inoculation. This high rise of temperature is followed by a sudden drop. In the most acute course of experimental infection the curve plunges from the highest peak down to subnormal temperature, and death occurs within one or two days

after the peak of the temperature curve has been reached. (See fig. 1, temperature curve of W–M–3, 4, 7, 11, 13.) The type of fever is intermittent, as is well revealed in those animals that survived. In such cases the repeated elevations are plainly discernible, each subsequent rise being less than the preceding one. (See fig. 1, temperature curve of W–M–6.)

AUTOPSY FINDINGS IN GUINEA PIGS

The post-mortem findings in those animals that died of infection by *Leptospira icterohæmorrhagiæ*, isolated in Manila, varied somewhat as to intensity but they were typical in every case.

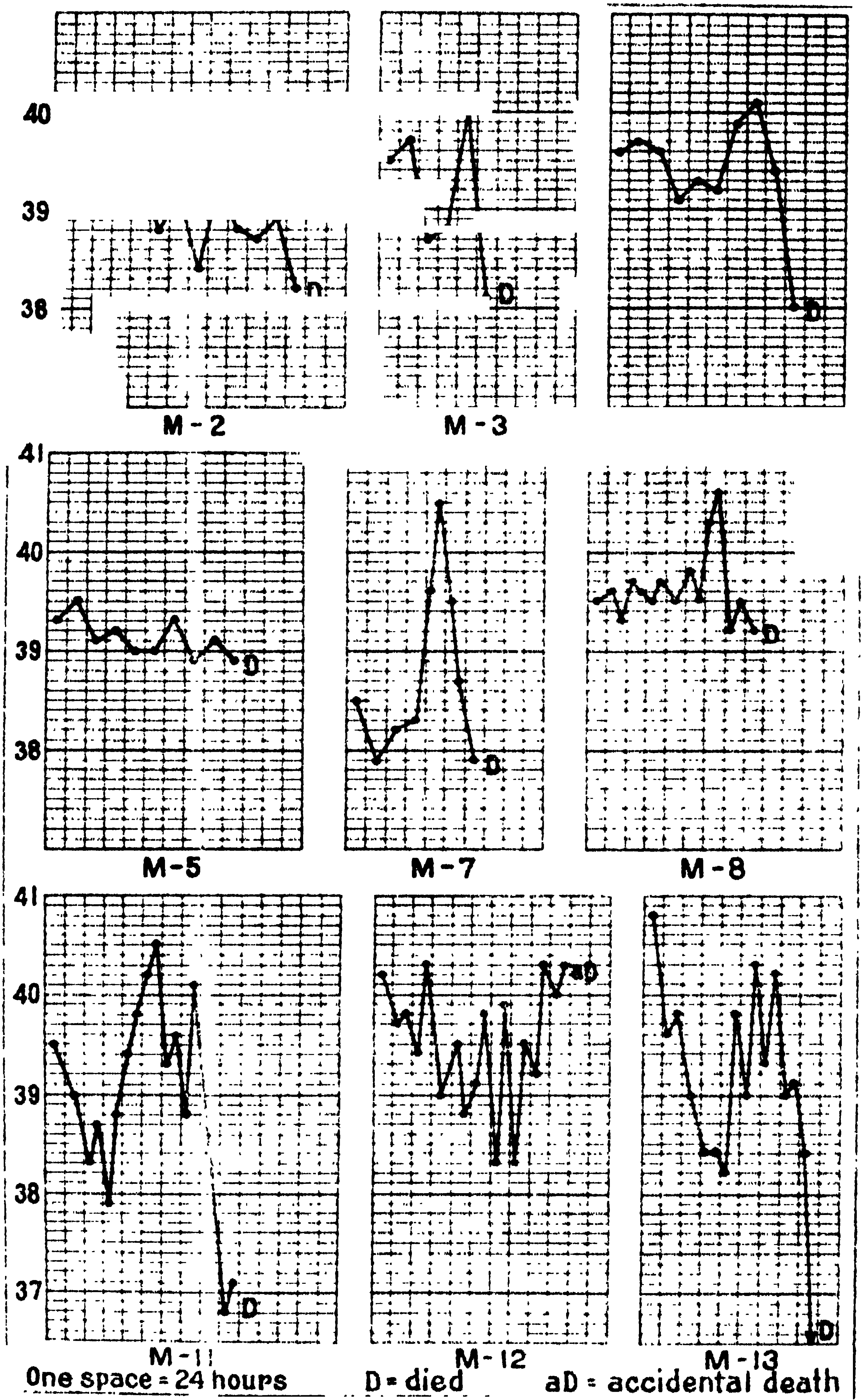
The characteristic jaundice plainly discernible before and after death upon external examination was in every case much more striking in the subcutaneous tissue. The axillary and inguinal lymph glands were enlarged and hæmorrhagic. Petechial hæmorrhages scattered throughout the subcutaneous tissue. Internal organs hyperæmic, showed the typical yellowish tinge. The lungs exhibited scattered hæmorrhages more regularly and to a greater extent than the other internal organs.

Microscopic examination confirmed the autopsy findings as to the hæmorrhages. Parenchymatous cells were found degenerated. Sections prepared from pieces of liver that were stained by Levaditi's method presented fairly numerous spirochætes. These were scattered, isolated, throughout the parenchyma of the liver and occasionally in groups, and clusters of the leptospiræ were encountered in the interstitial tissue.

CARRIERS IN EXPERIMENTAL ANIMALS INOCULATED WITH MANILA STRAIN OF LEPTOSPIRA ICTEROHÆMORRHAGIÆ

In the course of inoculations from animal to animal, it was observed that occasionally guinea pigs developed fever and even icterus, but recovered. The leptospiræ could not be demonstrated in the blood of these animals by microscope. However, a certain time after recovery numerous leptospiræ were found in the urine of the animals. The elimination through urine of leptospiræ in these animals was intermittent. Samples of urine contained at times numerous leptospiræ, while it was impossible to demonstrate them in the urine of the same animals the next day.

It appears significant that none of the animals inoculated with the urine obtained from carriers and which contained numerous leptospiræ died of the infection. Some, however, presented typical fever (M–19).



40
39
38
M-2
M-3
D
41
40
39
38
M-5
M-7
M-8
41
40
39
38
37
M-11
M-12
M-13
aD
One space = 24 hours
D = died
aD = accidental death

FIG. 1.

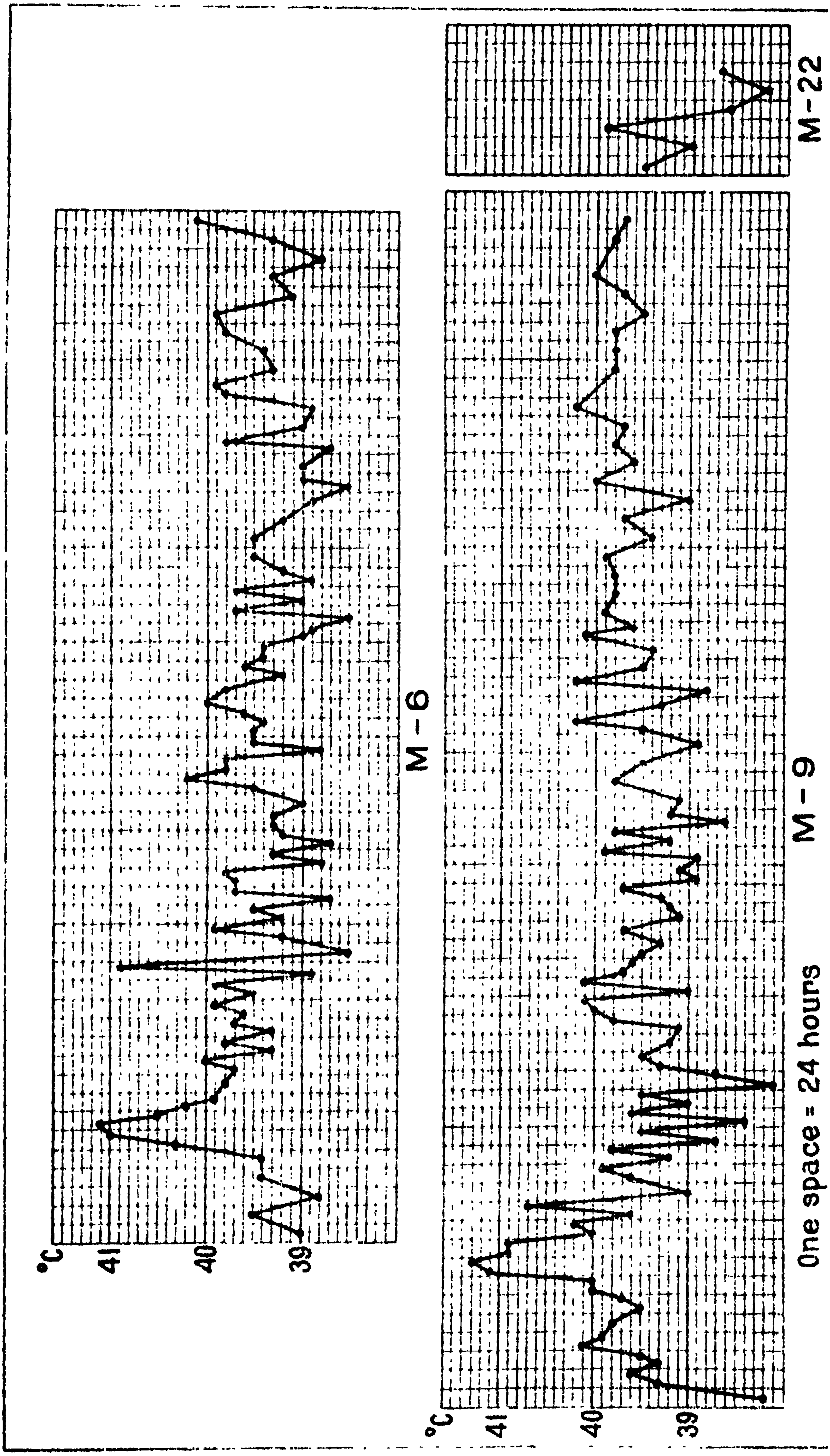
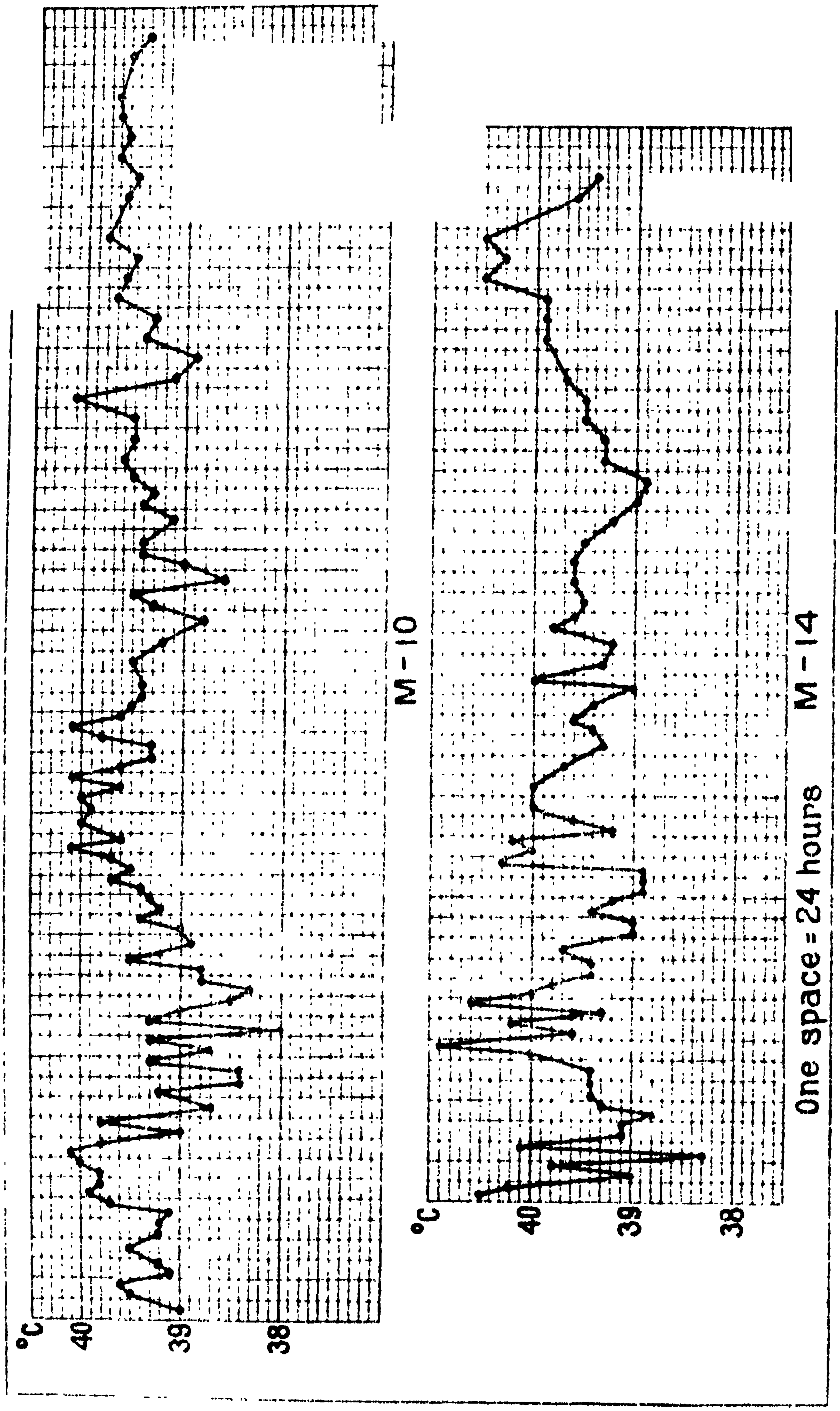


Fig. 1a.


°C
40
39
38
M-10
°C
40
39
38
M-14
One space = 24 hours

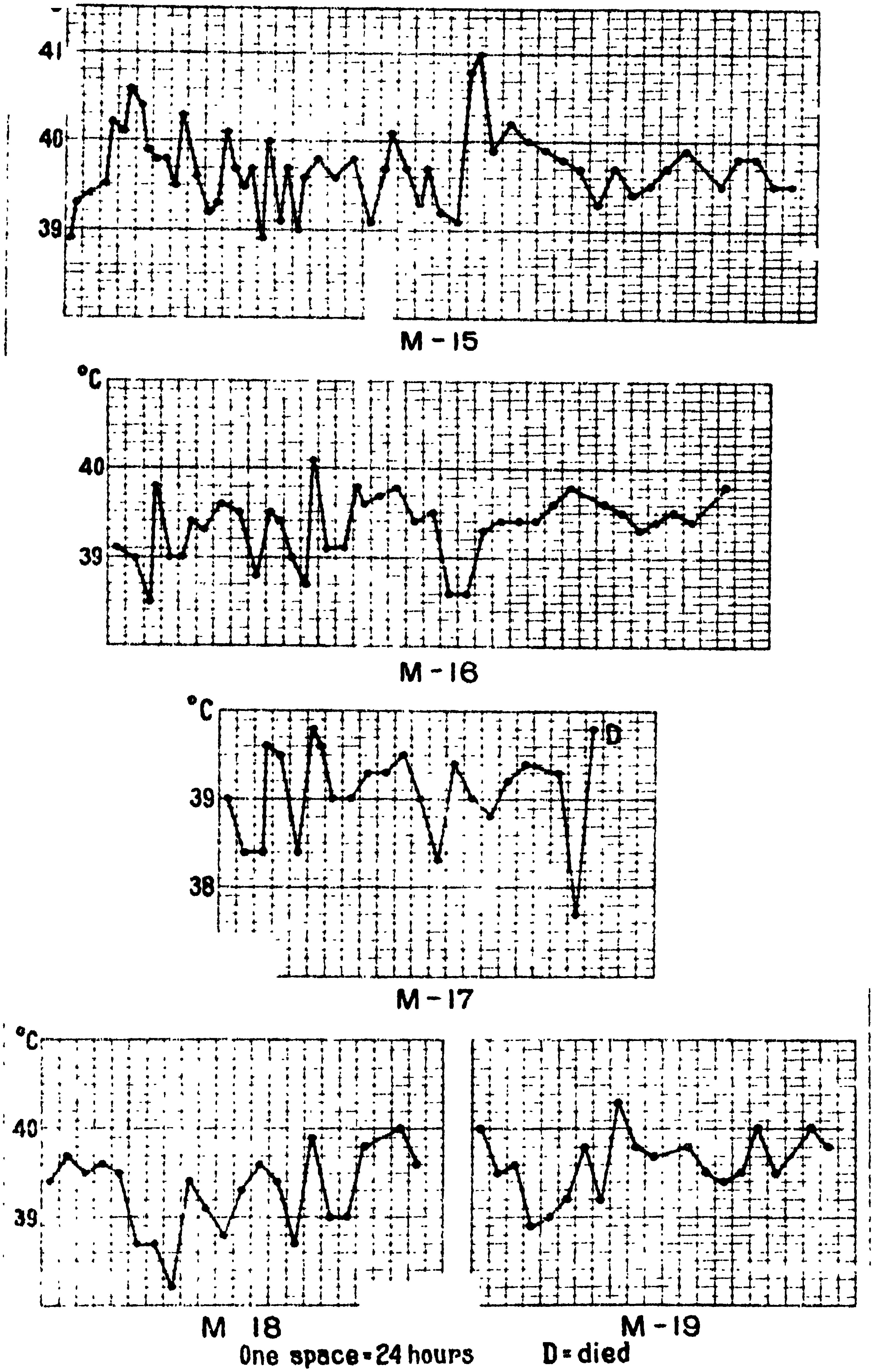

41
40
39
M - 15
°C
40
39
M - 16
°C
39
38
D
M - 17
°C
40
39
M 18
M - 19
One space = 24 hours
D = died

Fig. 1c.

The mortality among white mice inoculated with the Manila strain of *Leptospira icterohæmorrhagiæ* was even lower than that among guinea pigs. The carrier state, however, was frequently encountered in these animals. The carrier state could be transmitted from mouse to mouse while the donor as well as the recipient remained alive.

SUMMARY

From the urine of a fatal case of infectious jaundice, in a long time resident of Manila, morphologically and biologically typical *Letospira icterohæmorrhagiæ* was isolated. Typical symptoms; that is, fever, hæmorrhages, and icterus, were produced in guinea pigs by passage inoculation and leptospiræ were demonstrated in these animals by dark-field, stained preparations, and Levaditi sections. The virulence to experimental animals (guinea pigs and white mice) was found relatively low in comparison with the virulence of the Japanese strains studied. The attempt to increase the virulence by successive passages through susceptible animals (guinea pigs and white mice) had, as a consequence, diminished rather than increased virulence. While more than half of the passage animals died an acute death with typical clinical and post-mortem findings, some of them recovered, showing only mild or no clinical symptoms. Of those that recovered, a certain number became carriers, discharging in their urine large numbers of leptospiræ, which when transferred to normal animals failed to produce death, but induced symptoms and carrier state.

CONCLUSION

The existence of Weil's disease in the Philippine Islands, indicated by previous findings among rats by McKinley, is confirmed by demonstrating *Leptospira icterohæmorrhagiæ* in the urine of a fatal human case of infectious jaundice.

The strikingly low virulence of the Manila strain, particularly as regards animal carriers, is offered, for the present, as an explanation of the paucity of Weil's disease in Manila among rats as well as humans.

ILLUSTRATION

TEXT FIG. 1. Chart showing temperature curves of guinea pigs inoculated with a Philippine strain of *Leptospira icterohæmorrhagiæ*.

OBSERVATIONS ON THE POSSIBLE TRANSMISSION OF SURRA BY THE LAND LEECH HÆMADIPSA ZEYLANICA

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ONE PLATE

INTRODUCTION

One of the biological differences that may be said to exist between the trypanosomes of fishes and other aquatic cold-blooded vertebrates and the trypanosomes of mammals and other warm-blooded vertebrates is their mode of transmission. So far as known, the trypanosomes of the former group of animals are conveyed by leeches while those of the latter group are usually transmitted by blood-sucking insects. These modes of propagation are readily understood if it is recalled that the transmission of specific infections by intermediaries is only possible if the animals harboring the infections are easily accessible to the transmitting agents. This being the case, it could hardly be suspected that blood-sucking insects would serve as appropriate transmitters for the trypanosomes of aquatic cold-blooded vertebrates. But it so happens in the case of leeches that they also attack warm-blooded vertebrates, especially mammals, and it is evidently for this reason that they have also been incriminated in the transmission of mammalian trypanosomes.

During an outbreak of horse trypanosomiasis in Annam, Vassal (1906) carried out some experiments in order to determine the mode of propagation of the disease. He used leeches, ticks, fleas, and several species of blood-sucking flies. His results were negative, but he made an interesting observation that the trypanosome responsible for the disease was unable to live long in the digestive tract of the leeches (species not mentioned). He tested the blood ingested by the annelids from infected animals by injecting it into rats and found that it was infective immediately after a meal of blood but not four hours later.

In the Philippines Boynton (1918), while engaged in looking for an invertebrate reservoir host of the virus of rinderpest, inquired into the possible transmission of surra by the carabao leech, *Hirudinaria manillensis.* He fed leeches partially on guinea pigs heavily infected with surra trypanosomes and after lapses of certain lengths of time (7 minutes to 2 days) allowed them to bite healthy animals. He also triturated one leech in physiological salt solution two days after it sucked infected blood and injected it into a normal guinea pig. The results of the experiments were all negative and it was concluded that the carabao leech cannot hold the trypanosome of surra alive for any length of time and that it cannot transfer the disease by biting.

In a recent publication Seegert (1930) has incriminated leeches (species not mentioned) in the spread of Mal de Caderas in Brazil. He cites the observations of Brazilian farmers to the effect that in outbreaks of the disease the removal of infected herds to high places where there are new sources of water supply serves to prevent the propagation of the infection. Similar results are said to be obtained in spite of the presence of large numbers of *Tabanus* flies, which are the suspected carriers of the disease, if sick horses are separated from healthy ones by a simple wire fence. According to Seegert, the incidence of Mal de Caderas in Brazil is low during the months immediately preceding the rainy season when *Tabanus* flies are very numerous; on the contrary it is high when these flies are scarce, coinciding with the prevalence of leeches, which in tropical countries are said to hibernate during the dry season and begin to come out shortly before and after the rainy season. The people are said to see to it that their animals avoid certain known water holes, due to a traditional belief that horses will contract the disease if allowed to drink at these places. Seegert examined leeches from one of these water holes where a sick animal had been found. He encountered trypanosomes that he believed to have something to do with Mal de Caderas but which Doctor Cesar Pinto, of the Instituto Oswaldo Cruz, whose opinion was sought, considered as developmental stages of a frog parasite. Finally Seegert cites Professor Doctor von Bassewitz, of Porte Alegre, who used leeches in treating his riding horse (what the treatment was for is not stated), which developed Mal de Caderas as a result of the treatment. The case was reported at a meeting of naturalists in Hamburg in 1928.

In view of this uncertainty of opinion on the rôle of leeches in the transmission of mammalian trypanosomes and because it

was felt that the question has not yet been thoroughly studied, judging from the scanty literature available, it was decided to undertake the present reported work.

MATERIALS AND METHODS

The trypanosome studied is a strain of *Trypanosoma evansi* which was originally obtained from a surra horse about a year ago and has since been maintained in the laboratory by direct passage to guinea pigs.

Two species of leeches were utilized in the transmission experiments: the water leech, *Hirudinaria manillensis* (Lesson) (=*Hirudo boyntoni*, Wharton, 1913), commonly known as the rice-field or carabao leech (Plate 1, fig. 1) and the land leech, *Hæmadipsa zeylanica* (Plate 1, fig. 2). The former, as one of its names imply, is commonly met with in rice fields and also in swamps, ponds, and sluggish streams in the costal provinces of India, Ceylon, China, and the Malay Islands including the Philippines. It is often employed as a medicinal leech in many of these countries. Among the domesticated animals, carabaos are its most frequent victims and, as already mentioned, it is the form used by Boynton in his experiments on rinderpest and surra.

The land leech, *Hæmadipsa zeylanica,* including its several varieties, is found in humid places, especially in the lower ranges of the hill-countries of southeastern Asia, the Malay Archipelago including the Philippines, and other Oriental countries. It is a tormenting pest to human beings and animals travelling through mountain forests in these regions. Tennent (1861), Wallace (1902), and other naturalists who visited these countries all wrote accounts of their experiences with this leech. Tennent says that "Horses are driven wild by them (land leeches); they stamp the ground in fury to shake them from their fetlocks, to which they hang in bloody tassels."

Before starting on the transmission experiments, it was considered necessary to perform preliminary viability tests in order to ascertain how long the surra parasite is able to survive in the bodies of the leeches after it is sucked by the latter with the blood of infected animals. If it is determined that the trypanosome cannot remain alive in the annelids for a reasonable length of time, then there is very little possibility, if any, of the disease being carried by the leeches. The method employed consisted in allowing the annelids to feed on heavily infected laboratory animals until they became engorged with

blood. Then from time to time samples of blood were drawn from their digestive tracts by means of fine sterilized needles and syringes and injected subcutaneously into white mice. In some cases where it was difficult to obtain blood with a syringe, the leeches were cut into small pieces and triturated with sterile salt solution and the fluid portion of the mixture injected into mice and guinea pigs.

The transmission experiments were carried out in the manner that similar experiments on surra have been performed with the use of blood-sucking insects; that is, by means of interrupted feedings. One or more leeches of the same species were allowed to bite a heavily infected laboratory animal for a few minutes. They were then removed to clean containers and after varying intervals of time (1 to 105 minutes) they were placed on a healthy host. In some cases they were kept alive for much longer periods, up to one and a half months, after which they were examined carefully for living trypanosomes or developmental stages of these organisms. They were then cut into small pieces and triturated with sterile physiological salt solution and were either fed or injected (the supernate) to mice and guinea pigs.

Usually it was not found difficult to make the leeches continue their blood meal when removed from one animal to another. When newly captured and hungry, they attached themselves readily to any portion of the body surface of a mouse, rat, or guinea pig, but preferably to the inner surfaces of the hind legs, the soles of the feet, or around the mammary glands where the hair is less dense or absent. The only precaution taken was not to allow them to suck too long (not more than 4 minutes from the time they began to suck) from the first animal, otherwise it was difficult or even impossible to induce them to take a second meal of blood. In the case of the land leech, however, after it had been kept in the laboratory for a few days, it usually became less active and less disposed to bite. It was induced to suck by shaving the skin or by applying it on wounded surfaces where other leeches had previously bitten.

RESULTS OF EXPERIMENTS

For convenience, the results of the various experiments have been condensed and incorporated in Tables 1 to 5.

TABLE 1.—*Length of time Trypanosoma evansi remains infective in the digestive tract of Hirudinaria manillensis.*

Interval after biting infected host.	Blood from leech injected to mouse No.—	Date of injection (1931).	Fate of animal receiving injection.
H. m.			
0 10	1	May 26	Positive June 1; died June 4.
1 20	4	June 1	Positive June 6; died June 8.
2 30	5	do	Negative; kept under observation for 25 days. [a]
3 28	6	do	Do.
72 0	3	do	Do.

[a] In this and in the rest of the experiments, in which negative results were obtained, the susceptibility of the different animals was subsequently proven by inoculating them with viable trypanosomes.

Length of time Trypanosoma evansi survived in the digestive tract of Hirudinaria manillensis.—As shown in Table 1, the length of time that the surra trypanosome was able to live in the digestive tract of the carabao leech was quite brief. Blood samples taken from leeches up to one hour and twenty minutes after they were allowed to bite heavily infected animals were infective when injected to mice, but not after two and a half hours. Microscopic examinations of the gut contents, when they were no longer infective, revealed the presence of numerous dead trypanosomes. They appeared stiff and without visible undulating membranes.

TABLE 2.—*Length of time Trypanosoma evansi remains infective in the digestive tract of Hæmadipsa zeylanica.*

Interval after biting infected host.	Blood from leech injected to—	Date of injection (1931).	Fate of animal receiving injection.
H. m.			
1 0	Mouse 8	June 11	Positive June 16; died June 19.
2 0	Mouse 9	do	Positive June 16; died June 18.
3 0	Mouse 13	July 8	Positive July 8; died July 13.
3 20	Mouse 10	July 11	Positive July 16; died July 19.
4 15	Mouse 11 and rat 1	July 17	Mouse positive July 25, died July 30; rat positive July 27, died August 2.
5 45	Rats 2 and 3	do	Both negative; kept under observation for 50 days.
23 20	Mice 12 and 13	July 21	Both negative; kept under observation for 46 days.

Length of time Trypanosoma evansi survived in the digestive tract of Hæmadipsa zeylanica.—As shown in Table 2, the period of time that the surra trypanosome was able to remain alive in the digestive tract of the land leech was much longer than in the carabao leech. Blood samples taken up to four hours and fifteen minutes after the leeches were allowed to suck from infected animals were infective when injected to mice, but they were not infective after five hours and forty-five minutes. Microscopic examinations of the gut contents when they were no longer infective, revealed the presence of numerous disintegrating trypanosomes and, in some cases, motile ones or what appeared to be their developmental forms. These latter, however, as will be shown later, have nothing to do with the surra parasite.

TABLE 3.—*Direct transmission experiments with Hirudinaria manillensis.*

Interval between bites from infected to healthy animal.	Number of leeches applied.	Healthy animal exposed to leeches.	Fate of animal exposed.
Min.			
1	2	Guinea pig 1	Negative; kept under observation for 29 days.
3		Rat 2	Do.
10		Guinea pig 2	Negative kept under observation for 32 days.
60	3	Guinea pig 3	Do.
75	2	Guinea pig 5	Negative kept under observation for 35 days.
30	1	Mouse 14	Negative kept under observation for 28 days.
	3	Guinea pig 6	Negative, kept under observation for 35 days.
	1	Rat 3	Negative kept under observation for 25 days.

Transmission experiments with Hirudinaria manillensis.—As shown in Table 3, all attempts to transmit surra directly through the bites of one or more carabao leeches resulted negatively. The intervals between their bites from infected to healthy animals were from one to seventy-five minutes and were, therefore, within the length of time during which the surra trypanosome has been proven to remain alive in the digestive tract of *Hirudinaria manillensis.*

Some trypanosomes, such as *Trypanosoma lewisi, T. gambiense,* and others, are said to lose their virulence temporarily a few hours after they are taken up by their respective intermediate hosts and do not become infective again until after they have passed through definite cycles of development. To determine if *T. evansi* undergoes cyclic changes within the body of *Hirudinaria manillensis,* leeches that had sucked infected

blood were kept alive for twenty-nine to forty-four days in order to allow the parasite an opportunity to develop. Afterwards some of the leeches were allowed to bite healthy animals while others were either fed or injected to normal guinea pigs. As shown in Table 5, the results of the experiments were negative. The microscopic examination of the leeches for developmental forms of trypanosomes was likewise negative.

TABLE 4.—*Direct transmission experiments with Hæmadipsa zeylanica.*

Interval between bites from infected to healthy animal.		Number of leeches applied.	Healthy animal exposed to leeches.	Fate of animal exposed.
H.	*m.*			
0	2	2	Guinea pig 4	Negative; kept under observation for 32 days.
0	3		Mouse 7	Negative; kept under observation for 28 days.
0	5		Rat 4	Negative; kept under observation for 32 days.
0	5		Mouse 2	Positive on 5th day; died on 8th day.
0	30		Mouse 15	Positive on 7th day; died on 10th day.
0	25		Mouse 16	Negative; kept under observation for 20 days.
0	25		Mouse 17	Negative; kept under observation for 25 days.
1	35		Guinea pig 7	Do.
1	45	4	Mouse 19	Negative; kept under observation for 24 days.
0	30		Guinea pig 6	Negative; kept under observation for 28 days.
0	10		Guinea pig 9	Do.
0	13		Mouse 20	Do.
0	8		Guinea pig 10	Positive on 8th day; died on 23d day.
0	5		Guinea pig 11	Negative; kept under observation for 32 days.
0	10		Guinea pig 12	Do.
0	15	[a] 6	Guinea pig 14	Positive on 10th day; died on 52th day.
0	10	[a] 6	Guinea pig 15	Negative; kept under observation for 28 days.
0	15	2	Guinea pig 16	Do.
0	10	[b] 9	Guinea pig 17	Negative; kept under observation for 34 days.
0	7	[b] 9	Guinea pig 18	Positive on 9th day; died on 25th day.

[a] Two leeches applied on the same animal for three consecutive days.
[b] Three leeches applied on the same animal for three consecutive days.

Transmission experiments with Hæmadipsa zeylanica.—As shown in Table 4, five of the twenty experiments on the mechanical or direct transmission of surra through the bite of the land leech yielded positive results. These constitute the first experimental data available on the transmission of a mammalian trypanosome by an annelid.

As shown in Table 5, attempts to transmit the disease indirectly gave uniformly negative results, indicating that, as in the carabao leech, the surra trypanosome does not undergo cyclic development in *Hæmadipsa zeylanica.* The land leeches used were found to harbor a species of trypanosome or what

appeared to be its developmental stages, but these have no relation to *T. evansi* since they were not infective to mice, rats, and guinea pigs and, besides, were also found in leeches not fed on infected blood.

TABLE 5.—*Indirect transmission experiments.*

Leeches used.		Interval after leeches sucked infected blood.	Flagellated Protozoa found in leeches.	Method of infecting healthy animal.	Healthy animals exposed.	Result of experiment.
Kind.	Number.					
		Days.				
Hirudinaria	1	29	None	Saline suspension injected subcutaneously.	Two guinea pigs	Negative.
Do.	1	44	do.	Fed by mouth	do.	Do.
Do.	2	44	do.	Allowed to bite	One guinea pig	Do.
Hæmadipsa	1	25	Trypanosomes and crithidia.	Saline suspension injected subcutaneously.	Two mice	Do.
Do.	3	32	do.	do.	Three mice	Do.
Do.	2	32	do.	Allowed to bite	One guinea pig	Do.
Do.	3	44	do.	do.	do.	Do.
Do.	7	44	do.	Fed by mouth	Two guinea pigs	Do.

DISCUSSION OF RESULTS

No explanation can be given at the present time for the negative results obtained in the experimental transmission of surra by the use of the water leech, *Hirudinaria manillensis.* As far as I am aware, the question of why certain kinds of blood-sucking insects, such as *Tabanus,* can play the rôle of transmitters of the surra trypanosome while other kinds of blood-sucking flies, such as *Lyperosia,* seem unable to do so, has also not been explained. [Consult Kelser's (1927) summary of the literature and experiments on surra transmission by blood-sucking arthropods.] One thing seems apparent, however, and that is the nonoccurrence of a regurgitation process of the gut contents of this and also of the land leech during the act of biting, for otherwise the results of the transmission experiments would not have been so uncertain (see also below).

Evidence that the infection was conveyed in the contaminated proboscis of the land leech.—By allowing horse flies, which had previously been allowed to suck on a surra animal, to bite suc-

cessively three healthy horses, of which only the first one subsequently developed the disease, Mitzmain (1914) was able to prove that the infection is conveyed in the proboscis of the flies and "concluded that the biting of *Tabanus striatus* is innocuous in infecting more than one horse as a result of a previous contamination." Similar experiments were performed by substituting land leeches for horse flies and the results obtained were identical with that of Mitzmain. It appears, therefore, that the transmission of experimental surra by *Hæmadipsa zeylanica* is effected through the insertion of its soiled proboscis and that the leech, like the *Tabanus*, is capable of infecting only one animal as a result of a previous contamination.

Number of land leeches applied on individual animals.—As shown in Table 4, the number of leeches used in the experiments on mice do not appear to have decided the outcome of any particular experiment. But on guinea pigs the results were more certain when a larger number of leeches were transferred from an infected to a healthy animal. This is to be expected, for under equal circumstances the greater the number of leeches biting, the greater will be the probabilities of their transmitting the infection. Rogers (1901) in India, working with horse flies, also obtained more uniformly positive results by using a larger number of flies in each of his transmission experiments.

Intervals after biting infected hosts.—With insects like *Tabanus*, the question of the length of time that they can remain infective after soiling their probosces with the blood of an infected animal is not so very important, because they can fly from one animal to another with great facility. With leeches, however, which do not have the same facility of movement, this is a most important question in a consideration of their probable rôle in nature as transmitters of surra. In the experiments recorded in Table 4, the intervals between the bites in four of the cases in which positive results were obtained were from five to ten minutes, while in one experiment it was thirty minutes. Whether or not they could have remained infective after a longer interval than thirty minutes, the results of the experiments do not show. It is believed, however, that the intervals mentioned are sufficiently extended to allow these annelids, in their natural environment, to apply themselves to a fresh victim if they happened to get dislodged from a first one.

POSSIBLE IMPORTANCE OF THE LAND LEECH IN THE MECHANICAL TRANSMISSION OF SURRA IN NATURE

Having shown that experimental surra can be transmitted mechanically by *Hæmadipsa zeylanica*, the following questions now present themselves: Does the land leech indulge in interrupted feedings in its natural environment? To what possible extent can the land leech be a factor in the incidence of surra? As to the first question, it is reasonable to suppose that any animal, like a leech or even a *Tabanus*, if left undisturbed, would prefer to play safe and finish a full meal, once it had started, than to feed a little from one place and then from another, thereby running the risk of not obtaining a sufficient amount. It so happens in the particular case of blood-sucking flies that they are naturally subject to very frequent interruptions during the procurement of their food, due to the efforts of their victims to drive them away, and by going from one animal to another they incidentally serve to spread infections. Even leeches with their tenacity to cling to the bodies of their victims may also be subject to interruptions for they may be shaken or brushed from an animal's body by branches of trees and other vegetation under or through which the animal may be passing. If the annelid has just started to suck when it is thus thrown off, there is no reason why it should not complete its meal on another available animal. Experimentally, at least, it has been shown that it will do so.

Regarding the extent to which the land leech may possibly be involved in the natural transmission of surra, it has been mentioned that this annelid is confined in its distribution to moist mountainous places seldom frequented by horses, so that it would seem that it can only be of very small or even negligible importance in the propagation of the disease among domesticated animals. In certain instances, however, it may play a decidedly important rôle. It is known that there are animals, such as pigs [according to Baldrey (1910)], carabaos, and cattle that live in mountainous places, where *Hæmadipsa zeylanica* prevails, and which can harbor the surra trypanosome in the capacity of reservoirs. The land leech may be involved in the mechanical transmission of the parasite from one to another of these animals, as well as from any one of them to an occasional mountain visitor, such as a hunting dog or a mounted horse. The latter, if infected, returns to the lowlands and may then spread the infection to other animals through blood-sucking flies.

SUMMARY AND CONCLUSIONS

The suspected rôle of leeches in the transmission of mammalian trypanosomes has so far not been demonstrated experimentally. It was felt, judging from the scarcity of the available literature, that the question has not yet been thoroughly investigated and that further observations are necessary. For this reason it was decided to inquire into the behavior of a laboratory strain of *Trypanosoma evansi* of equine surra in the bodies of leeches and into the possibility of its being transmitted by them.

Two species of leeches were used in the experiments; namely, the water leech, *Hirudinaria manillensis* (Lesson), and the land leech, *Hæmadipsa zeylanica* (Moquin-Tandon).

By injecting the blood of leeches that had sucked infected animals into mice, at different intervals, it was determined that the surra parasite cannot survive long in the digestive tract of the water leech; it was infective up to one hour and twenty minutes after biting, but not after two hours and ten minutes. In the digestive tract of *Hæmadipsa zeylanica* it remained viable up to four hours and fifteen minutes, but not five hours and forty-five minutes after feeding.

By means of interrupted-feeding experiments it was also determined that the water leech is unable to transmit surra either directly or indirectly. On the other hand positive results were obtained by the use of *Hæmadipsa zeylanica*.

The evidence is that the transmission of the disease by the land leech was direct or mechanical, the infection being conveyed in the proboscis as the result of a previous contamination and retained for as long as thirty minutes.

Attempts to infect laboratory animals indirectly, by injecting or feeding them with the contents of land leeches that had been kept alive for as long as forty-four days after feeding on infected blood, yielded negative results. It may be concluded, therefore, that the surra trypanosome does not undergo cyclical development in the body of *Hæmadipsa zeylanica*.

Crithidial and trypanosomal flagellates were encountered in the digestive tract of some of the land leeches used in the transmission experiments, but they failed to infect when they were injected or fed to mice and guinea pigs. They were also found in leeches not fed on surra-infected blood, so that they probably represent parasites peculiar to the land leech or they are the developmental stages of a trypanosome other than *T. evansi*.

Taking for granted that the land leech can transmit surra in nature, as has been demonstrated experimentally, it would appear that it can only play a minor rôle as mechanical carrier during an outbreak of the disease due to its restricted distribution in places not usually frequented by domesticated animals. Its importance as a transmitter would be as an agent in the transfer of the parasite from some reservoir host that lives in the mountains, such as a pig or a carabao, to a chance animal, like a hunting dog or a horse ridden to the mountains. Any of the latter, if infected, or returning to the lowlands may spread the infection through the agency of blood-sucking flies.

ACKNOWLEDGMENT

I wish to thank Dr. D. Villadolid, of the College of Agriculture, University of the Philippines, for kindly confirming my identifications of the leeches used in the experiments. Doctor Villadolid compared my specimens with the leeches in the collection of the College of Agriculture, the determinations of which were made by Prof. J. P. Moore, of the University of Pennsylvania, Philadelphia.

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ILLUSTRATION

PLATE 1

FIG. 1. *Hirudinaria manillensis* (Lesson), ventral and dorsal views.
2. *Hæmadipsa zeylanica* (Moquin-Tandon), dorsal views.

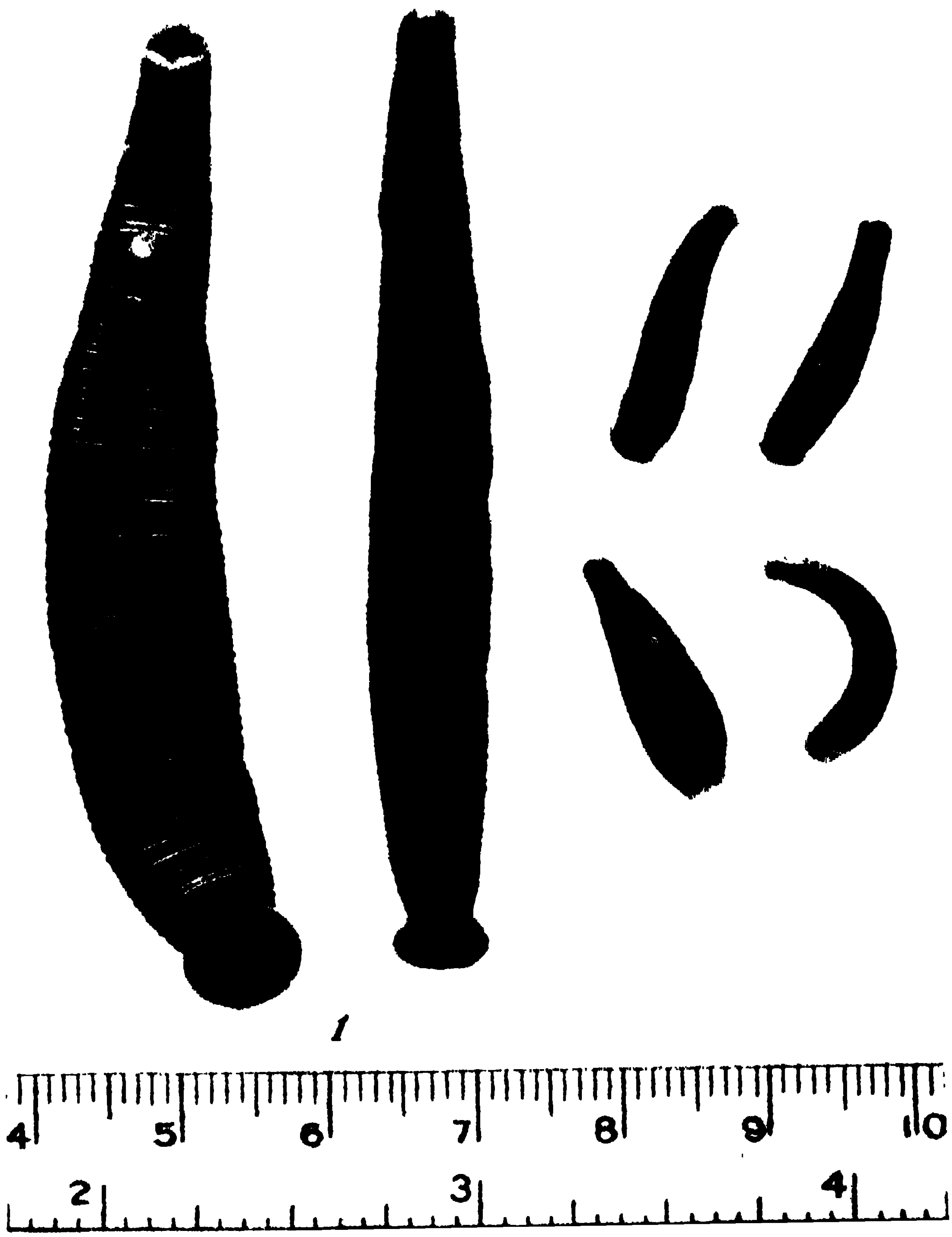

PLATE I

THE PHILIPPINE JOURNAL OF SCIENCE

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THE MOSAIC DISEASE OF SINCAMAS, PACHYRRHIZUS EROSUS (LINNÆUS) URBAN

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SIX PLATES

INTRODUCTION

The senior writer, while working with bean mosaic at the University of Wisconsin, noted a mosaic disease on *Pachyrrhizus erosus* (L.) Urb. in the pathological greenhouse. On his return to the Philippines, many other species of host plants affected with mosaic disease have been observed. Among these plants, the sincamas, *Pachyrrhizus erosus*, is one commonly affected. This plant is a native of Central America, but is now widely distributed throughout the Tropics. In the Philippines the sincamas either grows wild in thickets or is cultivated on a commercial scale for its sweet, fleshy taproot. This fleshy root is eaten raw, made into salads, or, when cooked, is mashed and eaten like turnips. Since the mosaic disease of sincamas is very common, and because of the economic importance of this food plant in the Philippines, an investigation of the disease should prove of value. It is, therefore, the purpose of this paper to report our observations and findings on the subject, particularly concerning the artificial and natural transmission of the disease and the chemical composition of the fleshy taproots of healthy and of mosaic-infected plants.

[1] The writers are grateful to Dr. W. H. Brown, director, Bureau of Science, and to Dr. C. J. Humphrey, mycologist, Bureau of Science, for helpful suggestions in the preparation of this manuscript.

GEOGRAPHIC DISTRIBUTION, OCCURRENCE, AND ECONOMIC IMPORTANCE

As far as the writers are aware, no report of the mosaic disease of the sincamas is found in literature. In the Philippines, the disease is very common in both cultivated and wild sincamas. It was observed in nearly all the provinces of Luzon visited where the sincamas is grown, and it probably occurs in other islands of the Philippines. From 80 to 100 per cent infection has been noted in most of the fields in the towns visited; namely, Mariquina, Rizal Province; Calamba, Laguna Province; Balayan, Batangas Province; Laoag, Ilocos Norte Province; Bauang, La Union Province; and several towns of Pangasinan Province.

As is true with a number of other minor crops in the Philippines, no authentic data on yield per hectare or loss due to mosaic disease are available. Since the disease affects the photosynthetic activity of the leaves, the fleshy root is generally reduced in size, depending upon the time of infection (Plates 4, 5, and 6). Likewise, as will be discussed later, the chemical composition of the root is altered by the presence of the virus.

GENERAL SYMPTOMS AND EFFECTS OF MOSAIC

The symptoms displayed by a sincamas plant infected with mosaic in the field or in the greenhouse are variable, as is the case with the other virus diseases.(6, 8) In general, varying degrees of mottling or chlorosis, and blistering of the leaves are noted (Plate 1, figs. 1, 2, 3; and Plate 2). The mosaic-infected plants are rarely killed, and in certain instances, plants with well-marked symptoms will later show only slight mottling or complete absence of symptoms on the succeeding leaves, and may remain as vigorous as the healthy ones. When infection takes place early and the symptoms are severe the plants are usually stunted, dwarfed, or spindly (Plate 3, fig. 2) and the leaves, as well as the fleshy taproot, are greatly reduced in size (Plate 4, fig. 2; and Plate 5, fig. 2). However, when plants are infected later in the season, the growth may be only slightly affected and the fleshy root only slightly reduced in size, if at all.

When healthy plants become infected during the growing season through the agency of insects or through artificial means, the first evidence of mosaic symptoms is observed in the young expanding leaves ten to fifteen days after inoculation. These leaves may be stiff, thickened, or chlorotic. The succeeding leaves show characteristic mosaic symptoms similar to those produced by plants originating in infected seeds.

As will be shown later, the sincamas mosaic is transmitted through the seeds of infected plants. The appearance of typical mosaic symptoms on seedlings originating from infected seeds may develop early and are manifested either by chlorosis, mottling, or blistering of the simple or first compound leaves of the plant. Under certain circumstances, however, these symptoms are delayed so that the first leaves may appear healthy or may show only a slight crinkling or a slight twisting of the leaf blades. The typical mosaic symptoms, indistinguishable from the field or greenhouse symptoms, however, are later produced on the succeeding leaves. Plate 3, fig. 2, is a photograph of a young plant infected from the seed, showing chlorosis and twisting of the simple and compound leaves.

No characteristic symptoms are noted on the green pods, on the fleshy taproot, or on the seeds of mosaic-infected sincamas plants to distinguish them from those of healthy plants. Except for size, it is difficult to recognize any other differences between the infected taproot and the healthy one. The seeds from both healthy and infected plants look alike, in spite of the fact that some of those from the infected plants contain the virus.

DISTRIBUTION OF THE VIRUS IN INFECTED PLANTS

The virus of sincamas mosaic appears to be systemic. Its presence is most easily demonstrable in the plant parts that exhibit mosaic symptoms. Artificial inoculations with juice from the leaves and stems of an infected plant readily produce infection in young healthy plants. Attempts to inoculate young healthy plants by the watery juice of the taproot from mosaic plants, so far, have given negative results. Surface sterilization of seeds from infected plants with mercuric chloride ($HgCl_2$) (1 : 1,000) has no appreciable effect on the percentage of seed transmission, and this holds true whether or not the seed coats are removed before sterilization. This seems to indicate that the virus is not located in the seed coats but is likely present in the embryo of the seed, as in bean mosaic.(6)

TRANSMISSION OF SINCAMAS MOSAIC BY NATURAL MEANS

In several series of experiments conducted with the object of infecting healthy plants by natural means, negative results were obtained through infected soil, by contact with roots of infected plants, and also by contact with aërial parts of diseased plants.

In the attempt to transmit infection through the soil, seeds of healthy plants were planted in soil mixed with fresh, dried, or decomposed mosaic tissues. No infection resulted after fifty

days, indicating that the virus does not retain its infectious properties in dead tissues of infected plants and is perhaps never transmitted through the soil from one season to another.

To determine whether the disease is transmitted by root contact, seeds of healthy and mosaic plants were planted together in a pot and the roots allowed to intermingle. No positive results were obtained.

The attempted transmission through contact with aërial parts of diseased plants was performed by allowing the vines of infected and healthy plants to intertwine, and the leaves to rub together casually under controlled conditions. No infection of the healthy plants resulted.

From the results of the above experiments, it is seen that the sincamas mosaic is not readily transmissible through cultural practices and, therefore, these practices are probably insignificant factors in the transmission of the disease in the field.

TRANSMISSION OF SINCAMAS MOSAIC BY ARTIFICIAL MEANS

Leaf inoculation.—The methods of artificial inoculation known to transmit tobacco or cucumber mosaic were tried with sincamas mosaic, but the results were negative. Successful inoculations, however, were obtained by using the leaf-mutilation method employed by Fajardo(6) in the artificial transmission of bean mosaic. In these trials from 40 to 80 per cent infection was obtained. Typical symptoms developed fifteen to twenty-five days after inoculation.

Transmission by insects.—Field observations indicated that the increase in the percentage of field infection might be due to insects. Five plants protected from insects by cloth cages remained healthy, while plants not protected from insects showed 100 per cent mosaic infection before the end of the season.

In two series of plantings made in the pathological plot in Manila, seeds of infected plants were sown from 3 to 5 centimeters apart in a 1-by-6-meter plot. The percentage of seedlings infected from seed origin was recorded, and the rate of field transmission observed each month. It was found that the increase of field transmission was associated with the appearance of the mealy bug *Ferrisia virgata* Ckll.,[2] and whenever plants became infected, this insect was usually found. As shown in Table

[2] The writers are indebted to Dr. L. B. Uichanco, professor of entomology, University of the Philippines, for the determination of the mealy-bug species.

1, the rate of spread starts slowly, and gradually increases until 100 per cent infection is reached.

TABLE 1.—*Showing the rate of spread of sincamas mosaic in the field.*

SERIES 1.

Plot.	Total plants observed.	Plants infected from seed.	Plants infected in the field.	
	February 12, 1931.[a]	February 12, 1931.	March 12, 1931.	May 12, 1931.
		Per cent.	*Per cent.*	*Per cent.*
Plot I	96	17.8	41.6	100
Plot II	104	25.0	51.8	100
Plot III	114	35.0	65.8	100
Plot IV	106	27.3	68.1	100

SERIES 2.

Plot.	April 12, 1931.[b]	April 12, 1931.	May 12, 1931.	June 12, 1931.
Plot I	104	28.0	42.3	100
Plot II	52	11.5	17.8	100
Plot III	93	31.2	40.2	100
Plot IV	40	20.0	22.5	100

[a] Seeds planted December 20, 1930. [b] Seeds planted March 10, 1931.

Controlled transmission experiments with F. virgata Ckll.—Controlled experiments in the greenhouse with mealy bugs (*F. virgata*) thus far have failed to transmit the virus readily to healthy plants. Seeds of healthy plants were sown in greenhouse benches or in pots covered with celluloid cylinders[3] immediately after planting. As soon as the plants were in the third to sixth compound-leaf stage, ten average-sized mealy bugs reared on mosaic plants were transferred to each plant. In two series of experiments conducted in the above manner, no infection developed on the ten healthy experimental plants at the end of thirty-five days when the final notes were made.

In another set of experiments, mosaic and healthy plants were grown together in the same pot and caged immediately after planting with celluloid cylinders. Mealy bugs from infected plants were then introduced into the cage and allowed to colonize on both mosaic and healthy plants. At the end of two months when the final notes were made, only slight chlorosis was noted on the leaves from the five healthy plants under observation. Plate 6 shows the celluloid cylinders and the mealy bugs, *F.*

[3] Humphrey, C. J., Philip. Journ. Sci. 48 (1932) 259.

virgata, used in the attempts to transmit the virus to healthy sincamas plants.

The results of the above experiments in the greenhouse seem to indicate that the common mealy bug cannot transmit the virus readily to healthy plants. It is, therefore, doubted at present whether this insect plays any rôle in the spread of sincamas mosaic in the field. In this connection it must be considered, however, that other insects besides mealy bugs were also observed in the field, so that further studies on insect transmission must be made before definite conclusions can be reached.

SEED TRANSMISSION

While seed transmission occurs with both lettuce mosaic(12) and cucumber mosaic,(3) this means of infection is not common in the seeds of mosaic-infected nonleguminous hosts. With the mosaics of leguminous plants, however, it is found that infection of the seed by the virus is rather general and common. Kendrick and Gardner(9) reported seed transmission for soy-bean mosaic, McClintock(11) for lima bean, Dickson(2) for garden pea, red clover, alsike clover, and sweet pea, and Reddick and Stewart(13) and Fajardo(6) for the garden bean.

Our results have shown that sincamas mosaic is also transmitted in the seed of the infected sincamas plant. Seeds gathered from five mosaic-infected sincamas plants were divided into two lots. In the first lot the seeds were planted 2 to 3 centimeters apart in a field where sincamas had not been grown before. The second lot of seeds was planted in the same manner but 50 meters away from the first planting. The percentage of plants infected through diseased seeds was recorded after the plants had reached their first, second, or third compound-leaf stage. Of two hundred eighty-nine plants counted in the first planting, and four hundred twenty plants in the second planting, 25 per cent and 26 per cent, respectively, showed infection. In another series, seeds obtained from another source of unknown origin were planted in 8-inch pots in the greenhouse. Of fifty plants examined 5 per cent were infected.

Further experiments were performed, where infected seeds were first surface sterilized with mercuric chloride ($HgCl_2$) (1:1,000) and washed in sterile water. After this treatment the seeds were divided into two lots. In one lot, the seed coats were removed, and in the other lot, they were left intact. The two lots of seeds were then planted separately in 5-inch pots in

the greenhouse. The results show that there is no marked difference in percentage of seed transmission whether the seed coats are removed or not.

The above findings show that the sincamas mosaic is transmitted in the seeds of infected plants; that it is perhaps carried in the embryo of the seed, as in bean mosaic,(6) and that the percentage of seed infection varies in the different lots of seeds obtained from different sources. No evidence was found to show that the viability of the infected seeds is affected by the presence of the virus in them. The vigor of the plant, however, is affected if the infection has its origin in the seed and if the leaf symptoms are severe. It was likewise observed that plants originating from infected seeds do not all develop symptoms at the same time. From 10 to 15 per cent showed symptoms of mosaic later in the development of the plant. This result may in part explain why the increase of mosaic infection in the field cannot be all accounted for as due to insect transmission.

PRESENCE OF VIRUS IN THE FLESHY TAPROOT OF INFECTED PLANTS

In a series of experiments, it was found that the fleshy taproots of mosaic sincamas plants were also infected with the virus. Ten plants of infected seed origin, and five plants from healthy seeds were allowed to grow in the field until their taproots developed to marketable size. In order to avoid field infection the five healthy plants were covered with cloth cages, while the ten mosaic plants were left exposed. After two and one-half months, these plants were pulled up, the tops removed, and the taproots allowed to dry at room temperature for two months. After this period they were all planted separately in large pots. The new shoots, or sprouts, from the ten infected taproots all showed mosaic symptoms, while those from the five healthy taproots remained healthy.

In another series, twenty-five plants secondarily infected in the field were pulled up and the taproots likewise allowed to dry at room temperature for more than two months. They were then replanted in a new field where sincamas had not been grown before. After one and one-half months when notes were made, all showed infection. The symptoms of mosaic were evident on the first few leaves that developed from the new shoot.

Confirmatory of the above experiments, count was made of the plantings of local farmers from their own selected stock

of "mother taproots."[4] It was found that the infection varied from 20 to 100 per cent. This part of the plant, therefore, serves to carry the virus from one season to another, as in the case of beet "stecklings,"[5] or mother sugar beets, where the virus of sugar-beet mosaic overwinters.(14) The relative vigor and viability of the shoot coming from the infected taproot, however, does not seem to be affected by the presence of the virus.

SINCAMAS MOSAIC AND BEAN MOSAIC NOT IDENTICAL

Cross-inoculation studies by the leaf-mutilation method have shown that the virus of sincamas mosaic does not infect the bean, *Phaseolus vulgaris* L. In this connection, earlier studies made by the senior writer on bean mosaic(6) also indicated that bean-mosaic virus is not transmissible to other leguminous or nonleguminous hosts. From these results, it is apparent that sincamas mosaic is different from bean mosaic and probably specific to the sincamas, *Pachyrrhizus erosus* (L.) Urb.

CHEMICAL ANALYSIS

Preparation of samples and methods of analysis.—Unless otherwise stated, only the edible fleshy taproot of the plant was examined for its chemical composition. In the selection of these samples, full-grown mosaic and healthy plants from the same plot, all planted at the same time, were pulled and topped on the same day, and the fleshy roots taken into the laboratory for chemical analysis. A single fleshy taproot from each individual plant was freed from the adhering particles of dirt, sliced into small pieces, and dried at 80° C. in a vacuum oven. The dried tissues were then passed through a drug mill, and the powder thus obtained was analyzed as one separate sample. The dry matter of the sample was obtained by drying freshly cut pieces of the fleshy taproot in a vacuum oven heated at 100° C. until the weight was constant. In the case of the material used for the determination of acidity, the fleshy taproot from each plant, after being cleaned of dirt, was ground in a meat grinder and

[4] In the production of seeds, the fleshy taproots ("mother taproots") of sincamas are pulled up in February or March, hung in bunches, and stored in a shed or house to dry. After three or four months they are planted. From these plantings seeds for the current season are gathered. These seeds are planted in November or December, and the fleshy taproots for commercial purposes are pulled between January and April.

[5] According to Robbins,(15) "stecklings" are beets held overwinter for the production of seed the following season. Prior to digging in the fall, the tops are mowed off, and the "stecklings" are then siloed in earth trenches.

the expressed watery juice immediately analyzed for the acid content.

The reducing sugars, total sugars, dextrin, and starch were determined according to the procedure followed by Link and Tottingham,(10) except that the cuprous oxide resulting from the reduction of Fehling's solution was found by the volumetric thiosulphate method.(4, p. 191) For the crude fiber, pentosans, and total ash the samples were analyzed according to methods of the Association of Official Agricultural Chemists.(4) The total nitrogen (including nitrates) was determined by the usual method.(15) The hydrogen-ion concentration of the juice was obtained by using the potentiometer method, while the "titratable acid" was determined by titrating a given amount of the juice with N/10 potassium hydroxide, using phenolphthalein as indicator.

CHEMICAL COMPOSITION OF MOSAIC AND HEALTHY FLESHY TAPROOTS

In a series of analyses, it was found that there are certain consistent differences in the chemical composition of the healthy and infected fleshy taproots of the plants. As shown in Table 2, the infected taproots contain a comparatively lower percentage of reducing sugar, total sugars, pentosan, and dry matter than the healthy ones. The infected taproots have a considerably higher starch content than the healthy ones. The other carbohydrate constituents show no consistent parallel variations. Except for the starch content our results are in accord with the chemical findings of Brewer, Kendrick, and Gardner(1) on the tomato mosaic and those of Dunlap(5) on the tobacco mosaic. The exceedingly high amount of starch in the taproot of the infected plants cannot be explained until further studies have been made.

In regard to the total nitrogen content of the healthy and infected fleshy taproot, our results show only slight differences. These apparent slight differences in total nitrogen, however, cannot be interpreted as proving that other nitrogenous constituents of the plant are not affected by the virus. No conclusion, therefore, can be arrived at until after the data on the nitrogen partition can be obtained. In this connection, Jodidi, Moulton, and Markley,(7) working on the mosaic disease of spinach, found that the lower nitrogen content of the diseased tissues is one of the striking characteristics of the infected plant.

TABLE 2.—*Chemical composition of the fleshy taproot of healthy and infected sincamas, Pachyrrhizus erosus (L.) Urb.*

[All figures indicate percentages.]

Condition of sample.[a]	Carbohydrates.[b]						Dry matter.	Total ash.[b]	Total nitrogen.[b]	Protein (N x 6.25).
	Reducing sugars.	Total sugars.	Dextrin.	Starch.	Pentosans.	Crude fiber.				
Healthy	17 62	43.80	4.96	0.30	2.45	10.60	17.48	3.19	1.73	10 81
Do	20.68	51.02	6.18	0.74	2.79	9 61	16 25	2 39	1.42	8.87
Mosaic	16 80	38 80	6 03	5 11	1.65	6.18	13 96	2.52	1.25	7.81
Do	13.70	37.07	4.97	7.72	1.81	9.32	10.64	2.66	1.52	9.50

[a] Each sample represents a single fleshy taproot from one plant.
[b] Percentages are based on moisture-free samples.

With respect to acidity, it was found that there is a difference in the p_H value and "titratable acid" of the juice of infected and healthy taproots. As shown in Table 3 the infected taproots have higher p_H values, but lower "titratable acid," than the healthy ones.

TABLE 3.—*Acidity of the juice of infected and healthy fleshy taproots.*

Healthy.			Mosaic.		
Sample No.	p_H value.	"Titratable acid" (c.c. N/10 KOH).[a]	Sample No.	p_H value.	"Titratable acid" (c.c. N/10 KOH).[a]
	7.08	11 20	1	7 74	9 34
2	7 10	11 12	2	7 42	8 40
3	7 12	11 08	3	7.54	8.62
4	7.20	10.85	4	7 67	9.15
Average	7 12	11 06	Average	7 59	8 88

[a] This is expressed by the number of cubic centimeters N/10 potassium hydroxide required to neutralize the acidity in 100 cubic centimeters of juice.

SUGGESTIONS FOR THE CONTROL OF SINCAMAS MOSAIC

The evidence obtained from this investigation, that the disease is perpetuated from year to year through seeds or taproots of infected plants and that insects are generally responsible for field transmission, suggests the following control measures: (*a*) The use of disease-free seeds, (*b*) the testing of seed lots in advance and the planting only of seeds with a low percentage of infection, (*c*) the application of sprays or dusts as insecticides or repellants for the insects, and (*d*) the selection and breeding for disease-resistant varieties.

Since the virus is carried in the seed of the infected sincamas plant, careful selection of healthy plants for seed purposes cannot be overemphasized. Obviously, the selection of healthy "mother taproots" should not be overlooked. Seed lots from unknown sources intended for field planting should be tested in advance and only seeds with a low percentage of infection should be selected for planting.

Since no experiments have been conducted in the use of sprays or dust as insecticides or repellants no recommendation can be offered concerning their efficacy in the control of the disease. The field transmission, however, can be minimized by "rogueing out" infected plants as early as possible, and from time to time thereafter, before insects become numerous.

SUMMARY

1. A mosaic disease of sincamas, *Pachyrrhizus erosus* (L.) Urb., is described and reported for the first time in the Philippine Islands.

2. The disease is very common on cultivated and wild sincamas in nearly all the provinces of Luzon, causing as high as 30 to 100 per cent infection.

3. The virus is systemic, being present in all aërial vegetative parts of mosaic plants, as well as in the seed and in the fleshy taproot.

4. Attempts to transmit the disease through soil, through contact of roots, and through the aërial parts of plants resulted in failure.

5. Artificial transmission by using the leaf-mutilation method of inoculation was successful.

6. Although the mealy bug *Ferrisia virgata* Ckll. is common in the field, our experiments under controlled conditions in the greenhouse have failed to show that this insect transmits the virus from diseased plants to healthy ones.

7. The sincamas mosaic is transmitted through the seed and through the fleshy taproot of infected plants. These parts of the plant, therefore, serve to carry and spread the disease from one locality to another and from year to year.

8. The seedlings originating from infected seeds manifest a wide variation of symptoms. Likewise the appearance of the symptoms in some seedlings is delayed.

9. The relative vitality of the seeds or shoots arising from infected fleshy roots seems to be unaffected by the presence of the virus. The vigor of the plant, however, is affected when the infection occurs early or when it is transmitted through seed.

10. Chemical analysis shows that the infected fleshy taproot has lower percentages of reducing sugars, total sugars, pentosans, and dry matter, but a higher percentage of starch, than the healthy one. The acidity of the juice from fleshy taproots of infected plants is less than that of the juice from healthy ones.

11. The methods of control suggested are: (*a*) Production of mosaic-free seeds by careful selection of healthy plants, (*b*) testing of seed lots in advance and the planting only of seeds that are free or nearly free from infection, (*c*) early "rogueing out" of mosaic plants from time to time, and (*d*) development and use of resistant varieties.

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ILLUSTRATIONS

PLATE 1

VARIATION IN LEAF SYMPTOMS EXHIBITED BY SINCAMAS PLANTS INFECTED BY MOSAIC DISEASE

FIGS. 1 and 3. Leaves with marked mottling and blistering. Note the dark-green puckered areas near the veins and veinlets.

FIG. 2. Leaf with slight mottling but no reduction in size.

4. Leaf of a healthy plant.

PLATE 2

Enlarged photograph of the leaf shown in Plate 1, fig. 1. The dark-green puckered areas and the extensive clearing of the blade are well shown.

PLATE 3

PHOTOGRAPH OF YOUNG PLANTS GROWN FROM HEALTHY AND INFECTED SEEDS

FIG. 1. Healthy seedling.

2. Infected seedling with severe leaf symptoms. Note the arching of the simple young first compound leaves. These leaves are chlorotic and slightly mottled. Associated with these symptoms, the plant is dwarfed.

PLATE 4

EFFECT OF MOSAIC DISEASE ON THE SIZE OF THE FLESHY TAPROOTS

FIG. 1. Fleshy taproot from a healthy plant.

2. Fleshy taproot from a plant infected early, showing severe symptoms on the leaves.

PLATE 5

COMPARATIVE YIELD OF TAPROOTS FROM FIVE MATURE HEALTHY AND FIVE MATURE MOSAIC-DISEASED SINCAMAS PLANTS FROM THE SAME FIELD

FIG. 1. Taproots from healthy plants.

2. Taproots from mosaic infected plants. These plants were infected early in the season. Note the marked reduction in size of the fleshy taproots of mosaic-infected plants as compared with those of the healthy ones.

PLATE 6

THE CELLULOID CYLINDERS AND THE COMMON MEALY BUGS FERRISIA VIRGATA CKLL. USED IN MOSAIC-TRANSMISSION EXPERIMENTS

FIG. 1. Rows of cylinders where experimental plants are protected from incidental infection. The tops are covered with fine muslin cloth, which is tied tightly around the cylinders with a string. When insects are introduced, the cloth cover is removed, and then immediately replaced as soon as the insects are transferred.

FIGS. 2 and 3. The mealy bug *Ferrisia virgata* used in an attempt to transmit the mosaic virus to healthy plants. The bugs are introduced to the experimental plants by means of a camel's-hair brush.

PLATE 1.

PLATE 2.

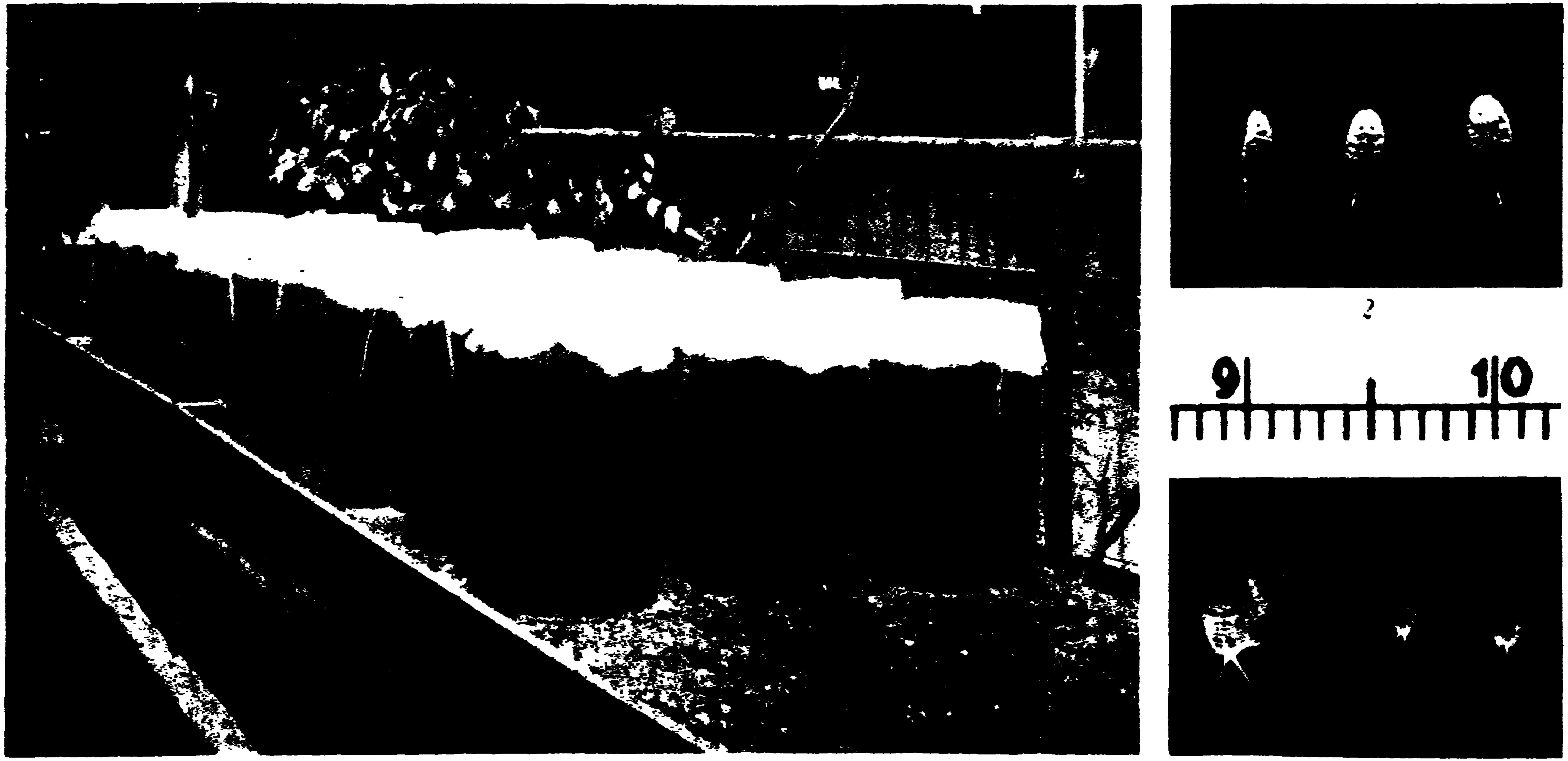
1 2

PLATE 3.

PLATE 4.

1 2

PLATE 5.



PLATE

AN ANATOMICAL STUDY OF THE WOODS OF THE PHILIPPINE MANGROVE SWAMPS[1]

By ALEXIS J. PANSHIN

Of the New York State College of Forestry, Syracuse

TWENTY-FOUR PLATES

INTRODUCTION

Mangrove-swamp vegetation is so strikingly unique among plant societies and so wide flung along the tropical coasts of both hemispheres that it has focused the attention of botanists from an early date. Much has been written on the ecology and physiology of the woody plants of this formation, especially of the genera *Rhizophora, Avicennia*, etc., but relatively little is known of the minute structure of their woods. It is the purpose of this article to present in detail the gross and minute anatomical features of the woods of the Philippine mangrove forest; and, in addition, to show what influence, if any, a highly saline and, therefore, "physiologically dry" habitat has had upon the wood structure of such littoral species.

MATERIAL AND METHODS

The material that has served as a basis for this work consisted of a set of wood samples obtained from Mr. Luis J. Reyes, of the Bureau of Forestry, Manila, Philippine Islands. Additional specimens from the Indo-Malayan Region in the wood collections of the New York State College of Forestry served for comparison. With but two exceptions the photographs were taken from the Philippine material; the samples of *Heritiera littoralis* Dry. and *Excoecaria agallocha* L. were too small for low-power photographs, and the illustrations of these woods were prepared from slides loaned by Dr. H. P. Brown from his collection of Indian woods.

The scientific names used in the text are those given in the list which accompanied the set of wood samples, except in two

[1] Contribution from the Department of Wood Technology, New York State College of Forestry, Syracuse.

instances; namely, the name *Rhizophora apiculata* Blume was substituted for *R. candelaria* DC., and *Avicennia marina* Vierh. for *A. officinalis* L.[2] The common and local names were taken for the most part from W. H. Brown.[3] The Engler system has been followed in the sequence of families.

The description of each wood is accompanied by a list of references to the species, and in many cases it has seemed advisable to abbreviate the author's name and the title of his work. The full list of references with complete titles is included in the general bibliography. The anatomical descriptions of the woods by species are divided into two parts; namely, general description of the wood and minute anatomy.

GENERAL DESCRIPTION OF THE WOOD

Under this title are included such characteristics as color, luster, odor, taste, hardness, relative weight and specific gravity, grain, texture, and such anatomical features as can be discerned directly from the wood with the naked eye or a 10x hand lens. Due mention is made of the differences in color between sapwood and heartwood, where the latter is distinct. The publications of Schneider and Foxworthy (see bibliography), where they deal with the descriptions and properties of species included in this investigation, were consulted in order to determine how closely the specimens at hand agreed with the observations of these authors. The specific-gravity data were either taken directly from Foxworthy's Commercial Woods of the Malay Peninsula, or compiled from the wood samples available at Syracuse.

Since much confusion exists in the usage of the terms "grain" and "texture" they are defined here (as accepted in the Department of Wood Technology, New York State College of Forestry) as follows: "Texture" is a measure of the size and the proportional amounts of woody elements, and, therefore, this term is used with such descriptive adjectives as "fine," "coarse," "uniform," etc.; the term "grain," on the other hand, is limited to the arrangement and to the direction or alignment of the elements and, therefore, is qualified by such adjectives as "straight," "interlocked," "curly," etc.

The term "growth ring" is used to designate a "seasonal increment," where the differences in structure are sufficiently pro-

[2] According to Dr. E. D. Merrill, *A. officinalis* L. has been collected only two or three times in the Philippines; *A. marina* Vierh. is very common in the Philippines and throughout Malaysia.

[3] Philip. Bur. Forestry Bull. 22 (1920).

nounced to be discerned with the naked eye. Vessel orifices in the transverse section are designated as "pores," and the expression "vessel lines" is applied to the vessels as they appear along the grain. The following arbitrary classification based on tangential diameters of the larger pores was adapted from Reyes.[4]

Vessels.	Tangential diameter. Microns.
Very small	50–100
Small	100–150
Medium	150–200
Large	200–250
Very large	250+

Parenchyma, unless visible to the naked eye or with a hand lens (10x), is considered as indistinct. When distinct three major types are recognized; namely, paratracheal (about pores); zonate (either paratracheal- or metatracheal-zonate); terminal (at the end of the growth ring). The wood rays are described according to the degree of visibility; as, "plainly visible to the naked eye," "barely visible to the naked eye" or "indistinct without a hand lens," and "barely visible with a hand lens." On the radial section a ray fleck is considered as "high" when it measures over 3 millimeters in height along the grain, "medium high" when it is from 1 to 3 millimeters, and "low" when it is less than 1 millimeter in height.

MINUTE ANATOMY

This subdivision includes the descriptions of the minute anatomical characters of the wood and such features of the individual elements as are discernible with the compound microscope. In this part of the text the terms "vessels" and "vessel groups" are used in preference to "pores" or "clustered pores" since the former describe best these composite elements. The diameters of the vessel orifices were always measured in the tangential plane, and the same procedure was followed in arriving at the diameters of the other elements (fibers, tracheids, and parenchyma cells).

In the description of parenchyma five types of cell arrangement are recognized; namely, "terminal," when the parenchyma cells are restricted to the outer margin of the seasonal ring; "paratracheal," when the parenchyma cells are associated with the vessels; "paratracheal-zonate," when two to many vessels

[4] Philip. Journ. Sci. 22 (1923) 291

are embedded or united by tangential bands of parenchyma; "metatracheal," where the parenchyma cells are more or less indiscriminately distributed throughout the growth ring, either singly or in small groups, but not definitely associated with the vessels; "metatracheal-zonate," a type in which the parenchyma is arranged in one to many seriate, concentric bands extending irrespective of the vessels.

Fibers are designated as "libriform," "semilibriform," or "nonlibriform" depending upon the thickness of the fiber walls, as compared with the diameter of their lumina. A fiber is said to be "libriform" when the thickness of the wall is equal to or is greater than the width of its lumen; "semilibriform" when the thickness of the wall is less than the width of the lumen but equal to at least a quarter of the total diameter of the fiber; and "nonlibriform" when the thickness of the wall is a quarter or less than the total diameter of the fiber. Fibers are described as "fine" when the maximum tangential diameter is less than 24 microns, "medium fine" when the diameter falls between 24 to 40 microns, and "coarse" when the fiber exceeds 40 microns in width.

The spacing of the rays was determined in the transverse section, but in woods possessing only the uniseriate type the number of rays per square millimeter, as seen in the tangential plane, was also taken; they were considered as "numerous" when the count was over 9 per millimeter; "fairly numerous" when 5 to 9 per millimeter; and "not numerous" or "scarce" when less than 5 per millimeter. In compiling data upon the ray size, the largest rays were selected and their height calculated as to number of cells and in microns; in addition the size of what appeared to be the average rays was likewise estimated. The rays were designated as "heterogeneous" when some of the cells were found to be at least twice the height of the others as viewed in radial and tangential sections. The taller cells following the usual custom were termed "upright" and the shorter cells "horizontal." It follows that the "heterogeneous" and "homogeneous" ray types intergrade and hence the decision as to ray composition was often of necessity more or less arbitrary.

In describing wood elements it was frequently found advisable to indicate the plane of section in which the observation was made, and in accordance with this the following abbreviations were adopted: *x* for the cross or transverse section; *t* for the tangential; *r* for the radial section.

The data on "uses" and "working properties" were compiled from different sources, particularly from E. E. Schneider, Commercial Woods of the Philippines: Their Preparation and Uses; and W. H. Brown, Minor Products of Philippine Forests.

ANATOMICAL DESCRIPTION OF WOODS BY SPECIES

APOCYNACEÆ

Trees, shrubs, often twining, rarely perennial herbs, with milky juice, opposite, whorled or rarely alternate, simple leaves, perfect flowers in terminal or axillary, solitary or corymbose cymes, and baccate, drupaceous, or follicular fruits. About 130 genera and over 1,000 species are included in this family, widely distributed throughout the world but chiefly tropical.

The Apocynaceæ are represented in the Philippines by 6 or 7 genera which include several well-known timber species. The most important of these is *Wrightia* R. Br.; this produces the "lanete" wood of the trade which, because of its light color, fine and even texture, and ease of working, is a favorite medium for fine carving. One species of *Cerbera* Linn. occurs in the mangrove forests of the Islands.

Genus CERBERA Linnæus

This genus consists of 4 or 5 species, which are restricted to the tropical tidal forests of Madagascar, Asia, and the Pacific Islands; *C. manghas* Linn. is the sole species in the Philippine flora.

CERBERA MANGHAS Linn. Plate 1.[a]

Common name.—Baraibai.

Local names.—Buto-butó (Surigao, Dinagat); bayag-usá, pandakáki (Camarines); baraibái (Baler); buta-butá (Bataan); bat'áno (Camiguin Island); kúbi (Zambales); ditá (Moro); lipáta (Palawan); panabulón (Negros); duñgás (Cotabato).

General description of the wood.—Wood dark grayish brown; heartwood lacking; dull, smooth to the feel, odorless, moderately hard and moderately heavy (specific gravity about 0.6), straight grained, fine textured; finishes smooth. Growth rings absent. Pores not numerous, evenly distributed, arranged in radial rows of two to many and the rows also in radial lines,

[a] *Literature.*—Brown, 1:76; Solereder, 1:53; Ridley, 2:339; Janssonius, 4:593 (*C. odollam*); Koorders and Valeton, 1:85; Hooker, 3:645; Heyne, 2 (1927) 1827; Merrill, 3:330.

very small, not visible to the naked eye, with occasional deposits of lustrous infiltration; vessel lines inconspicuous. Parenchyma in numerous, concentric, very faint, white, unevenly spaced lines. Rays numerous, not visible without a 10x hand lens; ray fleck medium low, inconspicuous, light yellowish brown. Ripple marks absent.

MINUTE ANATOMY

Vessels mostly in radial rows of 2 to 9, with contiguous rays on one and often on both sides, 12 to 16 per square millimeter; orifices more or less angular, the largest 80 to 100 microns in diameter; segments storied with the rays, 300 to 1,000 microns long, with long-attenuate or short and blunt tails; lateral walls 2 to 4 microns thick; perforations simple, horizontal or oblique, circular or elliptical, often located on the lateral walls and not infrequently paired at the end of a given segment; intervessel pits numerous, small (3 to 4 microns in diameter), round, bordered, with narrow orifices; pits leading to contiguous rays numerous to each ray cell, usually in 4 to 8 horizontal rows, simple or bordered, small (3 to 4 microns in diameter), rounded-oblong to elliptical, with broad orifices; tyloses sparse; gummy infiltration not observed.

Parenchyma paratracheal, metatracheal-zonate, and metatracheal, in cambiform rows of 2 to 8 units along the grain; (*a*) paratracheal parenchyma sparse; cells 40 to 60 microns in diameter, 100 to 180 microns long; (*b*) metatracheal-zonate parenchyma in concentric, unevenly spaced, 1- to 3-seriate bands separated by 6 to 40 fibers; cells 12 to 40 microns in diameter, 120 to 220 microns long; (*c*) metatracheal parenchyma sparse; cells similar to those of the *b* parenchyma; globules of light yellow, gummy infiltration frequently present; crystals not observed; starch deposits abundant.

Fibers nonlibriform, arranged in radial rows, nearly square or radially flattened in the transverse section, 30 to 40 microns in diameter, 700 to 1,500 microns long, nongelatinous and gelatinous in alternating bands; walls of nongelatinous fibers 3 to 6 microns in thickness; lignified portion of the wall of the gelatinous fibers 2 to 3 microns thick, the gelatinous layer 6 to 8 microns; interfiber pits mostly confined to the radial walls, simple or bordered, medium large (3 to 4 microns in diameter), round, with narrow, nearly vertical orifices; infiltration not observed.

Rays fine, 8 to 9 per millimeter, separated by 2 to 12 fibers, 1 or 2 (mostly 1) seriate, heterogeneous; the largest 16 to 20 microns wide and 12 plus cells and 500 plus microns high; "upright" cells marginal or interspersed, 40 to 80 microns long, 16 to 20 microns wide, 50 to 85 microns in height; "horizontal" cells 40 to 140 microns long, 8 to 16 microns wide, 25 to 35 microns in height; pits leading to contiguous vessels numerous, in 4 to 8 rows per cell, round, oblong, or elliptical, simple or bordered, with broad orifices; cells occasionally occluded by dark-colored gummy infiltration; crystals not observed; starch deposits abundant.

Remarks.—Interxylary phloëm has been reported in this species, forming a ring or in isolated bundles at the margin of the pith (Solereder 1: 55).

Material.—Block 3786 B. F., Palawan.

MELIACEÆ

The mahogany family consists of about 40 genera and over 800 species of trees, shrubs, and woody herbs, widely distributed in the tropical and subtropical regions of both hemispheres; a few species extend into the temperate zones. This family is the source of many valuable timbers, among which are included true mahogany, *Swietenia mahagoni* Jacq.; Spanish cedar, *Cedrela odorata* L.; the toon tree of India, *Cedrela toona* Roxb.; the Australian rosewoods, and most of the "African" mahoganies.

The Meliaceæ are well represented in the Philippines, but most of the species are neither large enough nor sufficiently abundant to be productive as a source of timber. Only four or five are commonly found on the market and of these, "calantas" (*Toona calantas* Merr. and Rolfe), which is practically identical with Spanish cedar, is the best known. *Xylocarpus* Koen. is represented by two or three littoral species that fall within the scope of this report; these produce mahogany-brown woods.

Genus XYLOCARPUS Koenig

This genus is represented by about 12 littoral species in western Africa, 2 or 3 species in tropical America, and 2 in the Philippines, *X. moluccensis* (Lam.) M. Roem. and *X. granatum* Koen.

Key to the species of Xylocarpus Koenig.

1. Heartwood deep wine-red, dull; ripple marks generally indistinct to the naked eye; largest vessels 110 to 120 microns in diameter; fibers nonseptate and septate; rays of two sizes, the smaller 1- or 2-seriate and storied with the vessel segments, the larger 3- to 5-seriate and extending over more than one tier..*X. moluccensis.*
1. Heartwood reddish brown, with golden luster; ripple marks distinct to the naked eye; largest vessels 120 to 160 microns in diameter; fibers always septate; rays uniform, 3- to 5- (mostly 3-) seriate, storied with the vessel segments ....*X. granatum.*

XYLOCARPUS GRANATUM Koen. Plate 2.[6]

Common name.—Tabigi.

Local names.—Tabigi (Lanao, Cebu, Tayabas, Guimaras, Zamboanga, Negros, Dinagat, Camarines, Masbate, Agusan, Sorsogon, Leyte, Marinduque, Panay, Basilan, Palawan, Samar, Cotabato, Culion); pulit (Basilan); lubanayong (Cagayan); kulimbaning (Culion); tambo-tambó (Zamboanga); nígi (Mindoro, Camarines, Palawan, Zambales, Tayabas); piagáu (Masbate, Zamboanga).

General description of the wood.—Sapwood narrow, whitish; heartwood dark reddish brown with golden luster; smooth to the feel; odorless; moderately hard, moderately heavy (specific gravity 0.65 to 0.80); straight or shallowly interlocked grained, fine textured, finishing smooth. Growth rings distinct. Pores not numerous, evenly distributed, solitary or in short radial groups, medium large and visible to the naked eye; vessel lines distinct, dark colored because of the infiltration. Terminal parenchyma in a fine, distinct line demarking the growth ring. Rays numerous, medium fine, barely visible to the naked eye; ray fleck low to medium high, relatively inconspicuous. Ripple marks present, distinct to the naked eye (*t*), about 26 per centimeter.

MINUTE ANATOMY

Growth rings demarked by a 3- to 5-seriate band of terminal parenchyma.

Vessels solitary or in short radial rows of 2 to 6, surrounded by an uniseriate sheath of parenchyma which is often interrupted by rays contiguous to the vessel, 14 to 16 per square millimeter; orifices round or oblong, the largest 120 to 160 microns in diam-

[6] *Literature.*—Brown, 1:36; Schneider, 138; Foxworthy, Philip. Journ. Sci. 482; Bull. Govern. British North Borneo 12, 36, 48, 58; Malayan Sci. Bull. 113; Foxworthy and Matthews, 5; Kanehira, (1924) 20, 61, 65; Whitford, 2:47; Gamble, (1922) 153; Brandis, 140; Troup, 1:186; Hooker, 1:567; Heyne, 2 (1927) 887; Boulger, 154.

eter; segments storied with the rays, plugged with a black gummy infiltration, 340 to 420 microns long, tailed or truncate; lateral walls 4 to 8 microns thick; perforations simple, round, horizontal or nearly so; intervessel pits very numerous, minute (2 to 3 microns in diameter), round to elliptical; pits leading to contiguous rays numerous to each cell, in 6 to 8 horizontal rows, elliptical to round; tyloses not observed; black gummy infiltration very abundant, occluding many vessel segments.

Parenchyma paratracheal, terminal, and metatracheal, in cambiform rows of 4 to 8 units along the grain which are frequently further divided into locules containing solitary crystals; (*a*) paratracheal parenchyma forming uniseriate sheaths which often encircle the vessel or vessel groups; cells thin walled, 24 to 40 microns in diameter, 60 to 120 microns long; dark brown to black gummy infiltration abundant; crystals present; starch deposits not observed; (*b*) terminal parenchyma in a 3- to 5-seriate band demarking the growth ring; cells thin walled, 24 to 40 microns in diameter, 80 to 100 microns long; dark brown gummy infiltration abundant; crystals present; starch deposits not observed; (*c*) metatracheal parenchyma sparse, the cells solitary (*x*), but otherwise similar to those of the *b* parenchyma.

Fibers nonlibriform to semilibriform, arranged in somewhat indefinite radial rows, septate, rounded in the cross section, 20 to 28 microns in diameter, 750 to 1,500 microns long; lateral walls 4 to 5 microns thick; interfiber pits sparse, simple, minute, slitlike; lumina occasionally plugged with a dark brown gummy infiltration.

Rays 6 to 8 per millimeter, 1- to 4- (mostly 3-) seriate, separated by 3 to 12 fibers, heterogeneous, storied; the largest 60 microns wide, and 30 plus cells and 550 plus microns high; "upright" cells marginal, 40 to 50 microns long, 20 to 30 microns wide, 40 to 60 microns in height; "horizontal" cells round (*t*), 80 to 160 microns long, 12 to 20 microns wide, 20 to 24 microns in height; pits leading to vessels numerous to each ray cell, in 6 to 8 rows, elliptical to round; dark reddish-brown gummy infiltration abundant, occluding most of the cells; crystals present, more numerous in the "upright" cells; starch deposits not observed.

Ripple marks distinct to the naked eye, traceable to the storied vessel segments and rays.

Material.—(1) Block 464 M. P., Manila Market; (2) Forest Experiment Station, Buitenzorg, Java; (3) Kuala Lumpur, Federated Malay States, F. W. Foxworthy, *Xylocarpus* sp.

Uses.—Poles, ties, posts, beams, doors, flooring, interior finish, high-grade furniture and cabinet work. It is considered among the best and most beautiful woods for cabinet work in the Islands.

XYLOCARPUS MOLUCCENSIS (Lam.) M. Roem. Plate 3.[7]

Common name.—Piagau.

Local names.—Piagau (Mindoro, Zamboanga, Negros, Cotabato, Palawan, and Guimaras); lagut-út (Guimaras); tabígi or tibígi (Mindoro and Cotabato); puyugáu (Ticao); sangkúyong (Moro and Jolo); piadak (Palawan).

General description of the wood.—Sapwood light brown; heartwood deep wine-red (darker than that of *X. granatum*); wood dull to somewhat lustrous, smooth to the feel, odorless, moderately hard and moderately heavy (specific gravity 0.65 to 0.80), straight grained, fine textured, working smooth under tools. Growth rings distinct. Pores few, somewhat more numerous at the inception of the ring, arranged in short radial groups, small, barely visible to the naked eye; vessel lines distinct, dark colored because of the presence of black infiltration which occludes many vessel segments. Parenchyma is distinct, concentric lines at the end of the growth rings. Rays medium fine, numerous, barely visible to the naked eye; ray fleck low to medium high, somewhat darker than the background, not very conspicuous. Ripple marks present but often indistinct without a 10x hand lens, about 25 per centimeter.

MINUTE ANATOMY

Growth rings demarked by a 2- or 3-seriate band of parenchyma, and in addition occasionally by a more-porous springwood zone containing crowded vessels.

Vessels solitary or in short radial groups of 2 to 4 (mostly in groups), surrounded by a uniseriate sheath of parenchyma which is often interrupted by rays contiguous to the vessel, frequently many united by concentric, inconspicuous bands of parenchyma, 12 to 15 per square millimeter; orifices round or oval, the largest 110 to 120 microns in diameter; vessel segments often storied with the low rays, 200 to 500 microns long, tailed

[7] *Literature.*—Brown, 1:38; Merrill, 2:358; Schneider, 138; Foxworthy, Malayan Sci. Bull. 113; Philip. Journ. Sci. 482; Bull. Govern. British North Borneo, 12, 36, 48, 58; Foxworthy and Matthews, 6; Whitford, 2:48; Kanehira, (1924) 20; Gamble, 153; Koorders and Valeton, 3:186–196; Brandis, 140; Ridley, 1:414; Moll and Janssonius, 1:206, Solereder, 1:224; Hooker, 1:567.

or truncate; lateral walls 4 to 6 microns thick; perforations simple, round, horizontal; intervessel pits numerous, minute (2 to 3 microns in diameter), crowded, rounded to hexagonal; pits leading to rays numerous to each cell, in 6 to 10 horizontal rows, elliptical; tyloses not observed; dark brown-black gummy infiltration very abundant, occluding many vessels.

Parenchyma paratracheal, paratracheal-zonate, terminal, and metatracheal in cambiform rows of 4 to 8 units along the grain which are often further divided into locules containing solitary crystals; (*a*) paratracheal parenchyma abundant, forming an uniseriate sheath; cells thin walled, 30 to 40 microns in diameter, 40 to 100 microns long; gummy infiltration sparse; crystals numerous; starch deposits present; (*b*) paratracheal-zonate parenchyma in concentric 2- to 3-seriate, concentric bands uniting many vessels; cells thin walled, 24 to 30 microns in diameter, 50 to 90 microns long; inclusions as above; (*c*) terminal parenchyma in a 2- or 3-seriate band; cells similar to those of the *b* parenchyma; (*d*) metatracheal parenchyma sparse; the cells solitary, otherwise similar to those of the *b* parenchyma.

Fibers nonlibriform to semilibriform, indistinctly arranged in radial rows, septate or nonseptate, rounded in the cross section, 20 to 30 microns in diameter, 750 to 1,500 microns long; lateral walls 4 to 6 microns thick; infiltration not observed; interfiber pits sparse, simple, very small, and slitlike.

Rays 5 or 6 per millimeter, separated by 3 to 12 fibers, heterogeneous, of two sizes: (*a*) small rays storied with the vessel segments, 1- or 2-seriate, 10 to 28 microns wide, 10 plus cells and 350 plus microns high: (*b*) large rays extending over more than one tier, 3- to 5-seriate, 60 plus microns wider, 30 plus cells and 850 plus microns high; "upright" cells marginal or interspersed, 40 to 60 microns long, 20 to 30 microns wide, 50 to 60 microns high; "horizontal" cells round (*t*), 80 to 120 microns long, 12 to 29 microns wide, 12 to 30 microns high; light brown gummy infiltration abundant; crystals common, more numerous in the "upright" cells; starch deposits sparse.

Ripple marks frequently indistinct without a 10x lens, traceable to storied vessel segments and rays.

Material.—(1) Block 5520 T. S., Tayabas; (2) Kyathnam, Burma.

Uses.—The wood of this species has the same uses as that of *X. granatum*.

EUPHORBIACEÆ

This family consists of more than 200 genera and over 4,000 species of herbs, shrubs, and trees, generally with milky juice which is frequently poisonous. These plants are widely distributed, especially in the Tropics, and are very variable in habitat. Taken as a whole, the Euphorbiaceæ are important as sources of products other than wood, among which the following deserve mention: Rubber, supplied by *Hevea braziliensis* (HBK.) Muell.-Arg., *Manihot glaziovii* Muell.-Arg. and species belonging to other genera; tapioca, from *Manihot utilissima* Pohl; castor oil, from the seeds of *Ricinus communis* L.; and various medicinal products from different genera. The most important timber-producing species is *Buxus sempervirens* Linn., which is the source of the Turkish boxwood of the trade.

In the Philippines this family is represented by many species, nearly all of which are small and hence unimportant as timber producers. Among the exceptions to this rule are *Bischofia javanica* Bl., a large tree with a reddish-brown, vinegar-scented wood, and various species of *Cyclostemon*, *Aleurites*, and *Endospermum*, which produce woods suitable for interior work; the woods of the last two are considered good in the Islands for matches and match-box veneers.

Genus EXCOECARIA Linnæus

This genus is confined to the Tropics of the Old World and consists of about 30 species of glabrous trees or shrubs with acrid, highly poisonous latex. *Excoecaria agallocha* Linn. occurs in the Philippines on firm mud and the sandy margins of mangrove swamps, also in relatively firm spots within the swamp interior.

EXCOECARIA AGALLOCHA Linn. Plate 4.[a]

Common name.—Buta-buta.

Local names.—Bat'áno (Pangasinan and Cagayan); butá (Basilan, Bataan, Mindoro, and Palawan); buta-butá (Bataan and Palawan); lipáta (Palawan, Agusan, and Camarines); lipátang-búhai (Palawan); alipáta (Negros); kulási (Tayabas and Lanao).

General description of the wood.—Heartwood not distinct; wood light grayish brown, dull, smooth to the feel, odorless,

[a] *Literature.*—Brown, 1:40; Merrill, 3:45; Foxworthy, Philip. Journ. Sci. 428, 431, 485; Foxworthy and Matthews, 9; Gamble, (1922) 626; Ridley, 3:314; Kanehira, (1921) 195; Hooker, 5:472.

but is said to produce a pleasant incense odor when burned, light, soft (specific gravity about 0.45), straight grained, fine textured. Growth rings absent. Pores very few, evenly distributed, solitary or in radial rows of 2 to 4, small, invisible without a 10x hand lens; vessel lines indistinct. Parenchyma in numerous, concentric, closely spaced, wavy lines, which are readily visible with a hand lens. Rays numerous, very fine, barely visible with a 10x hand lens; ray fleck low, about the same color as the background, inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Vessels solitary or in short radial rows of 2 to 4, with contiguous rays on one or both sides, often united by narrow concentric lines of parenchyma, 7 to 14 per square millimeter; orifices round to oblong, the largest 70 to 80 microns in diameter; vessel segments 500 to 760 microns long, tailed or truncate; lateral walls 3 to 4 microns thick; perforations simple, round or oblong, horizontal or slightly oblique; intervessel pits numerous, crowded, large (6 to 8 microns in diameter), rounded to hexagonal, with narrow orifices; pits leading to contiguous rays in 2 or 3 horizontal rows per cell, bordered, large (6 to 8 microns in diameter), rounded, oblong or elliptical, with narrow orifices; tyloses sparse; gummy infiltration not observed.

Parenchyma paratracheal and metatracheal-zonate, in cambiform rows of 2 to 6 (mostly 4) units along the grain; (*a*) paratracheal parenchyma sparse, forming an interrupted, uniseriate sheath around the vessels; cells thin walled, 28 to 40 microns in diameter, 100 to 160 microns long; (*b*) metatracheal-zonate parenchyma abundant, in concentric 1- or 2-seriate lines which alternate with wider bands of fibers and form a fine reticulum with the rays; cells thin walled, 20 to 32 microns in diameter, 160 to 240 microns long; gummy infiltration sparse in both types of parenchyma; crystals not observed; starch deposits abundant.

Fibers nonlibriform, aligned in radial rows, forming concentric 4- to 12-seriate bands which alternate with narrow lines of zonate parenchyma, rectangular in cross section, 20 to 26 microns in diameter, 850 to 1,400 microns long; walls 2 to 4 microns thick; intervessel pits numerous on the radial walls, minute, round, simple.

Rays very fine, close, 10 to 13 per millimeter (*x*), 25 to 30 per square millimeter (*t*), forming a fine reticulum with the zonate parenchyma, heterogeneous, the largest 30 microns wide, and 28

plus cells and 850 plus microns high; "upright" cells marginal and interspersed, 40 to 100 microns long, 10 to 30 microns wide, 34 to 60 microns high; "horizontal" cells round (*t*), 10 to 30 microns wide, 20 to 34 microns high; 80 to 160 microns long; pits leading to contiguous vessels in 2 or 3 horizontal rows per cell, large (6 to 8 microns in diameter), round to oblong or elliptical, bordered, with narrow orifices; light brown gummy infiltration occasional; crystals numerous; starch deposits abundant.

Material.—(1) Block 23133 B. F., Lanao; (2) 3779 B. F., Mindoro.

Uses.—Used for some kinds of furniture, toys, and fuel.

BOMBACACEÆ

This family consists of about 20 genera and 150 species of shrubs and trees, chiefly tropical. The arborescent forms are more valuable for their fibrous bark than for their timber. The family is represented in the Philippines by three genera, but only one species, *Ceiba pentandra* (Linn.) Gaertn., the cotton tree, is of any importance; this was introduced originally from tropical America and is now widely cultivated throughout the Islands for its cotton.

Genus CAMPTOSTEMON Martius

This genus is represented in the Philippines by one species, *C. philippinensis* (Vid.) Becc., a small unimportant tree of the mangrove swamps.

CAMPTOSTEMON PHILIPPINENSE (Vid.) Becc. Plate 5.[9]

Common name.—Gapas-gápas.

Local names.—Baluno and dandulit (Zamboanga); bungalon (Tayabas); gapasgapás (Negros, Zamboanga); libáto-putí, nigi-putí (Tayabas).

General description of the wood.—Heartwood lacking; wood pure creamy white, often blackened with sap stain if seasoned in the log, dull, smooth to the feel, odorless, soft to moderately hard, light (specific gravity about 0.5), straight or shallowly interlocked grained, fine textured, finishing smooth under tools. Growth rings absent. Pores not numerous, evenly distributed, solitary or in short radial groups of 2 to 4, very small (the largest barely visible to the naked eye); vessel lines distinct, darker than the background. Parenchyma in numerous, faint,

[9] *Literature.*—Schneider, 151; Foxworthy, Bull. Govern. British North Borneo, 6; Kanehira, (1924) 11.

white, concentric, closely spaced lines. Rays numerous, barely visible with a 10x hand lens; ray fleck low, inconspicuous, about the same color as the background. Ripple marks present, very conspicuous to the naked eye on the tangential and radial surfaces, about 30 per centimeter.

MINUTE ANATOMY

Vessels solitary or in short radial groups of 2 to 4, with a uniseriate sheath of parenchyma which is frequently interrupted by rays contiguous to the vessel, 8 to 13 per square millimeter; orifices round or slightly flattened radially, the largest 90 to 100 microns in diameter; vessel segments storied with cambiform rows of parenchyma, middle portion of fibers, and rays, 250 to 350 microns long, tailed or truncate; lateral walls 4 to 12 microns thick; perforations simple, round or elliptical, horizontal or slightly oblique; intervessel pits numerous, crowded, minute (1 to 3 microns in diameter), round, with broad orifices; pits leading to contiguous rays numerous to each cell, usually in 5 or 6 horizontal rows, small, round, simple or bordered; tyloses sparse; yellowish gummy infiltration present, occasionally plugging vessel segments.

Parenchyma paratracheal and metatracheal-zonate, in cambiform rows of 2 to 4 (mostly 2) units along the grain; (*a*) paratracheal parenchyma abundant, forming a narrow, usually uninterrupted sheath; cells 20 to 40 microns wide, 50 to 100 microns long; (*b*) metatracheal-zonate parenchyma in concentric, evenly spaced, 1- or 2-seriate lines which alternate with wider bands of fibers and form a fine reticulum with the rays; cells 16 to 20 microns wide, 125 to 170 microns long; gummy infiltration not observed in either type of parenchyma; crystals absent; starch deposits wanting.

Fibers fine, nonlibriform, aligned in radial rows, in concentric, 4- to 7-seriate bands which alternate with the lines of zonate parenchyma, short (650 to 850 microns), 12 to 16 microns in diameter, abruptly tapering and the median portion storied with the vessels segments and rays; walls 3 to 4 microns thick; interfiber pits numerous, simple, more abundant on the radial walls, with narrow, slitlike, nearly vertical orifices; infiltration not observed.

Rays very fine, close [12 to 16 per millimeter (*x*) and 35 to 40 per square millimeter (*t*)], forming a fine reticulum with the zonate parenchyma, separated by 2 to 5 fibers, 1- or 2- (mostly 1-) seriate, homogeneous or rarely heterogeneous, storied, with

the vessel segments, fibers, and cambiform rows of parenchyma; the largest 16 to 28 microns in width, 12 plus cells and 300 plus microns in height (maximum 15 cells and 350 microns); "horizontal" cells 30 to 80 microns long, 8 to 12 microns wide, 16 to 24 microns high; "upright" cells (where present) marginal, 30 to 50 microns long, 12 to 28 microns wide, 30 to 44 microns high; pits leading to contiguous vessels small (1 to 3 microns in diameter), numerous, usually in 5 or 6 horizontal rows, round, simple or bordered; infiltration, crystals, and starch deposits not observed.

Ripple marks visible to the naked eye, traceable to storied vessel segments, cambiform rows of parenchyma, fibers (expanded middle portion), and rays.

Material.—Block 18762 B. F., Zamboanga.

Uses.—Planks and temporary construction.

STERCULIACEÆ

The cacao family consists of about 50 genera and 750 species of trees, herbs, and a few climbers, widely distributed in the Tropics, a few extra-tropical. The best-known product of this family is cacao (cocoa), which is obtained from the seeds of *Theobroma cacao* Linn.; this small tree was originally indigenous to Brazil and is now widely cultivated in all tropical countries.

Genus HERITIERA Dryander

This genus embraces 6 or 7 tropical species, of which *H. littoralis* Dryand. is found in every province in the Philippines, in places bordering tide water and the inner edge of mangrove swamps.

HERITIERA LITTORALIS Dryand. Plate 6.[10]

Common name.—Duñgon-láte.

Local names.—Dúñgon-láte and dúñgon (Tayabas, Negros, Butuan, Camarines, Masbate, Lanao, Palawan, Zamboanga, Mindoro, Bataan, Cotabato, Zambales, Manila, Misamis, Leyte, Basilan, Surigao, Palaui Island, Sorsogon, Ticao, Guimaras, and Agusan); paunápin (Cagayan); magáyao (Cagayan); palugápig, paliñgapoi, paronápin, paronápoi (Cagayan, Pangasinan, and Zambales); baut (Moro); malarúñgon (Tayabas); pa-

[10] *Literature.*—Brown, 1:42; Merrill, 3:58; 4:25; Schneider, 151; Foxworthy, Philip. Journ. Sci. 500; Malayan Sci. Bull. 92; Bull. Govern. British North Borneo 26; Foxworthy and Matthews, 8; Gamble, (1922) 98; Koorders and Valeton, 2:170–174; Heyne, (1913–1917) 242; 2 (1927) 959, 1069; Whitford, 2:56; Baker, 47.

loñgápui (Ilocano); duñgon-lalao (Tayabas); bárit (Zamboanga); dumón (Cagayan); bayág-kabáyo (Manila).

General description of the wood.—Sapwood 6 to 8 centimeters thick, white to pale reddish; heartwood sharply delineated from the sapwood, dark reddish brown to dark chocolate brown, often with stony deposits in old knots and in heart cracks; wood dull, fairly smooth to the feel; often with a peculiar odor resembling that of old leather; tasteless; hard, heavy (specific gravity approximately 0.80), straight or shallowly interlocked grained, fine textured. Growth rings present but indistinct to the naked eye. Pores sparse, solitary or arranged in radial groups of 2 to 4, medium large, plainly visible to the naked eye, often occluded with reddish gummy or with white chalky deposits; vessel lines distinct because of the abundant reddish or white infiltration. Parenchyma in numerous concentric, very closely spaced lines which are often almost indistinguishable against the background. Rays numerous, medium large and distinct to the naked eye; ray fleck medium high, somewhat darker than the background but relatively inconspicuous. Ripple marks present on the tangential surface, often indistinct without a 10x hand lens, about 40 per centimeter.

MINUTE ANATOMY

Growth rings occasionally delineated by the crowding of the vessels at the beginning of the ring, often obscure at higher magnifications.

Vessels solitary or in short radial groups of 2 to 4, sometimes more crowded at the beginning of the ring, surrounded by a 1- to 3-seriate sheath of parenchyma which is occasionally interrupted by rays contiguous to the vessel, 6 to 10 per square millimeter; orifices round or oval, the largest 200 microns in diameter; vessel segments 250 to 375 microns long, truncate; lateral walls 6 to 8 microns thick; perforations simple, round or elliptical, horizontal or oblique; intervessel pits very numerous, crowded, minute (2 to 3 microns in diameter), round to elliptical; pits leading to contiguous rays similar to the intervessel pits; tyloses not observed; dark reddish gummy infiltration and white chalky deposits very abundant, occluding most of the vessels.

Parenchyma paratracheal and metatracheal-zonate, in cambiform rows of 2 to 8 units along the grain which are often divided further into locules containing solitary crystals, storied with the larger rays; (*a*) paratracheal parenchyma forming a 1- to 3-seriate sheath; cells thin walled, 24 to 40 microns in diameter,

60 to 100 microns in length, usually flattened to conform to the vessel wall; (*b*) metatracheal-zonate parenchyma in numerous, concentric, closely spaced, uniseriate lines which alternate with narrow bands of fibers and form a fine reticulum with the rays; rounded in cross section, thin walled, 20 to 28 microns in diameter, 40 to 100 microns in length; gummy infiltration present in both types of parenchyma, most abundant in that of the *b* type; crystals numerous, starch deposits not observed.

Fibers fine, semilibriform to libriform (mostly the former), not aligned in radial rows, in concentric 2- to 4-seriate bands which alternate with the uniseriate lines of zonate parenchyma, round or oblong in the cross section, 16 to 20 microns in diameter, 1,000 to 2,100 microns long; lateral walls 4 to 6 microns thick; pits simple, sparse, round, infiltration not observed.

Rays 4 or 5 per millimeter, separated by 8 to 10 fibers, forming a fine reticulum with the zonate parenchyma, 1- to 6-seriate, homogeneous or rarely heterogeneous; the larger storied, 70 microns wide, and 50 plus cells and 1,200 plus microns in height; "upright" cells (when present) marginal and interspersed, 20 to 40 microns high, 40 to 210 microns long, 8 to 16 microns wide; "horizontal" cells round or oblong (*t*), 10 to 20 microns high, 100 to 210 microns long, 8 to 16 microns wide; dark reddish gummy infiltration abundant; crystals present; starch deposits not observed.

Ripple marks present, traceable to storied rays (the larger), and cambiform rows of metatracheal parenchyma.

Material.—(1) Block 5391 B. F., Mindoro; (2) Kuala Lumpur, Federated Malay States, F. W. Foxworthy; (3) No. 6016 T. S., Tayabas.

Remarks.—Wood very strong and tough; extremely difficult to saw owing to the fact that the saws heat; excellent for piling and wherever heavy weights, with their accompanying stresses, must be borne.

Uses.—Pilings, posts, foundation sills, ties, and paving blocks; suitable for bridge, wharf, and ship construction; beams, tool handles, and mallets and other wooden tools; recommended for steamed bent work where strength and durability are required.

LYTHRACEÆ

This family consists of 22 genera and about 450 species of herbs, shrubs, and trees, widely distributed throughout the world where plants grow. Three or four genera are of importance in the Indo-Malayan Region as sources of valuable timbers, among

these, *Lagerstroemia* Linn. The wood of *L. speciosa* L. is said to be one of the finest in India. In the Philippines there are several genera and species of this family.

Genus SONNERATIA Linnæus f.

This genus consists of 4 to 6 species of large trees and shrubs, confined to the tidal tropical forests of the Old World. *Sonneratia caseolaris* (Linn.) Engl. and *S. alba* Sm. occur in Philippine mangrove swamps, but only the first is of commercial importance. For generic description of the wood, see the description of each species, as these two woods are very similar in structure.

Key to the species of Sonneratia Linnæus f.

1. Sapwood grayish brown, 3 to 8 centimeters wide; heartwood dark chocolate brown or black in old trees; fibers nonlibriform to semilibriform, 700 to 1,300 microns long; rays uniseriate........ *S. caseolaris.*
1. Heartwood generally not distinguishable; wood grayish brown; fibers nonlibriform, 600 to 1,000 microns in length; rays 1- or 2-seriate. *S. acida.*

SONNERATIA CASEOLARIS (Linn.) Engl. Plate 7.[11]

Common name.—Pagatpát.

Local names.—Pagatpát (Cebu, Camarines, Tayabas, Cagayan, Samar, Agusan, Basilan, Zambales, Cotabato, Palawan, Mindoro, Zamboanga, Panay, Guimaras, Negros, Leyte, Bataan, and Lanao); bunayon (Dinagat); patpát (Butuan); lukabbán, ilukabbán, lukabbáan (Cagayan); pirara and palalan (Cotabato); bun͠gálon (Masbate).

General description of the wood.—Sapwood grayish brown, 3 to 8 centimeters wide; heartwood dark grayish brown to chocolate brown, or almost black in old trees; wood dull to somewhat lustrous, smooth to the feel, with swampy odor and distinct salty taste, hard, moderately heavy to heavy (specific gravity 0.59 to 0.85), straight or slightly interlocked grained, fine textured, working to a very smooth finish. Growth rings distinct. Pores numerous, evenly distributed, arranged in radial rows of 2 to 4 or occasionally solitary, medium large, barely visible to the naked eye and appearing as numerous white dots, frequently plugged with tyloses; vessel lines inconspicuous; parenchyma

[11] *Literature.*—Brown, 1:46, Schneider, 178; Merrill, 3:138, 139; 4:26; Foxworthy, Bull. Govern. British North Borneo 38; Philip. Journ. Sci. 525; Whitford, 2:81; Kanehira, (1924) 37; Koorders and Valeton, 1:200.

indistinct. Rays very numerous, very fine, barely visible even with a 10x hand lens; ray fleck low, often of the same color as the background, inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Growth rings distinct, with sinuate margins, delineated by a narrow, denser zone, with fewer and smaller vessels, and several rows of radially flattened fibers.

Vessels somewhat smaller toward the end of the seasonal increment, evenly distributed throughout the ring with the exception of the narrow zone demarking its outer margin (fewer), in radial groups of 2 to 4 or rarely solitary, 25 to 30 per square millimeter; orifices round or oval, the largest 120 to 140 microns in diameter; vessel segments 225 to 750 microns long, with short and blunt, or long-attenuate tails; lateral walls 5 to 8 microns thick; perforations simple, round, horizontal or oblique; intervessel pits numerous, crowded, round or oblong, with fairly broad orifices; pits leading to contiguous rays round to oblong, 6 to 12 microns in diameter; tyloses very abundant, completely occluding the majority of the vessels; gummy infiltration sparse.

Parenchyma lacking.

Fibers semilibriform, aligned in radial rows, septate, 24 to 32 microns in diameter, 700 to 1,300 microns long; lateral walls 5 to 7 microns thick; lumina occluded with dark brownish-black infiltration; interfiber pits bordered, rounded or slitlike, with nearly vertical orifices.

Rays very fine, close, 14 to 16 per millimeter (x), 35 to 40 per square millimeter (t), separated by 1 to 4 fibers, uniseriate, up to 20 microns wide, and 20 plus cells and 700 plus microns in height; homogeneous or heterogeneous; "horizontal" cells 60 to 80 microns long, 12 to 20 microns wide, 20 to 30 microns high; "upright" cells (when present) 30 to 60 microns long, 12 to 30 microns wide, and 30 to 50 microns high; pits leading to contiguous vessels round or oblong, 6 to 12 microns in diameter; dark brownish-black gummy infiltration very abundant, occluding the majority of the cells; crystals present; starch deposits not observed.

Material.—13449 B. F., Zamboanga; block from Manila Market.

Uses.—Piles, posts, poles, ties, paving blocks; shipbuilding, bridge and wharf building; heavy construction of all sorts; doors, siding, ceiling, flooring, and interior finish; furniture, cabinet work, and musical instruments.

SONNERATIA ACIDA Linn. f. Plate 8.[11]

Common name.—Pedada.

Local names.—Payar (Pangasinan); palapát, palata, pagatpát, and hikau-hikáuan (Bataan); pagatpát (Manila and Bataan); lukabbán, ilukabbán (Cagayan).

General description of the wood.—Heartwood generally lacking; wood grayish to light brown, dull, very smooth to the feel, odorless, with a distinct salty taste, moderately hard, moderately heavy (specific gravity about 0.7), straight grained, even and fine textured. Growth rings distinct. Pores numerous, evenly distributed, arranged in radial rows of 2 to many or occasionally solitary, medium large, barely visible to the naked eye; vessel lines indistinct. Parenchyma indistinct. Rays numerous, extremely fine, barely visible even with a 10x hand lens; ray fleck low, of the same color as the background and hence inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Growth rings distinct, delineated by an irregular, narrow zone, with fewer and smaller vessels, and several rows of radially flattened fibers.

Vessels somewhat smaller toward the end of the seasonal ring, uniformly distributed with the exception of the narrow zone at the outer margin (fewer), solitary, and in radial groups of 2 to 4 or occasionally in nests of 3 to 6 (mostly in radial groups), with contiguous rays on one or both sides, 30 to 35 per square millimeter; orifices oval, the largest 110 to 130 microns in diameter; vessel segments 350 to 500 microns long, usually with a long-attenuate tail at one end, and short and blunt at the other end; lateral walls 4 to 6 microns thick; perforations simple, round or oblong, horizontal or oblique; intervessel pits numerous, crowded, round, with narrow orifices; pits leading to contiguous rays round, oblong, elliptical, or scalariform, in 2 to 3 horizontal rows per cell; gummy infiltration sparse; tyloses present, often sclerozed.

Parenchyma lacking.

Fibers nonlibriform to semilibriform, arranged in definite radial rows, septate, 24 to 32 microns in diameter, short (500 to 1,000 microns long); lateral walls 4 to 5 microns thick; inter-

[11] *Literature.*—Brown, 1:44; Schneider, 177; Merrill, 3:138; Foxworthy, Philip. Journ. Sci. 524; Foxworthy and Matthews, 8; Whitford, 2:81; Gamble, (1922) 377; Troup, 2:609; Ridley, 1:825; Moll and Janssonius, 3:598; Koorders and Valeton, 1:198; Hooker, 2:580.

fiber pits minute, bordered, round or slitlike, with nearly vertical orifices; dark brown gummy infiltration and crystalline deposits frequent.

Rays very fine, close, 16 to 18 per millimeter (x), and 55 to 60 per square millimeter (t), separated by 1 to 4 fibers, 1- to 2- (mostly 1-) seriate; the largest 35 microns wide, and 20 plus cells and 600 plus microns in height; homogeneous; cells 20 to 80 (mostly 20 to 40) microns long, 8 to 20 microns wide, 20 to 40 microns high; pits leading to contiguous vessels round, oblong, elliptical or scalariform, in 2 to 3 rows per cell; dark brown, gummy infiltration frequent; crystals numerous; starch deposits not observed.

Material.—(1) Block 5521 T. S., Tayabas.

Uses.—Cut only with the mixed firewoods.

RHIZOPHORACEÆ

Trees or shrubs with opposite or rarely alternate, simple, coriaceous leaves, small, perfect flowers in axillary clusters, and fleshy fruits, the seeds of which often germinate while the fruits are still attached to the tree. This family is distributed throughout the tropical and subtropical regions of the world and consists of about 15 genera and 50 species. Two tribes are recognized; namely, the Rhizophoræ which embrace the littoral species, collectively known as mangroves, and the Legnotidæ consisting of upland forms which flourish in regions often far removed from the ocean.

The Rhizophoraceæ produce a number of hard, heavy, fine-textured timbers which are only of local importance and are used mainly for fuel. The chief commercial product is tannin, obtained from the bark (10 to 30 per cent), especially from that of the littoral species; the collection of tan bark and the extraction of tannin are important industries in the Philippines and in other tropical countries.

In the Philippines the Legnotidæ are represented by the genus *Carallia* Roxb.; and the Rhizophoræ by the genera *Bruguiera* Lam., *Ceriops* Arn., and *Rhizophora* Linn., various species of which often grow in almost pure stands and comprise the bulk of the mangrove swamp.

The woods of the Rhizophoræ are featured as follows: Yellowish to orange-red or dark brown, with or without heartwood; dull to somewhat lustrous; hard; heavy; straight or shallowly interlocked grained and often with conspicuous silvery grain on the radial surface; fine textured. Growth rings absent or scarcely

distinct. Pores solitary or in short radial groups, 12 to 70 per square millimeter, small, barely visible to the naked eye in *Rhizophora* and *Bruguiera* and invisible without a hand lens in *Ceriops*, surrounded by a 1- to 2-seriate sheath of parenchyma; vessel segments tailed, 350 to 1,200 microns long, 50 to 100 microns in diameter, with scalariform perforations and numerous scalariform intervessel pits. Parenchyma paratracheal, paratracheal-zonate, and metatracheal, indistinct at low magnifications. Fibers semilibriform to libriform, aligned in rather indefinite radial rows, often septate, usually plugged with light brown infiltration. Rays numerous, visible to the naked eye, 1- to 8-seriate, high (the largest over 1 centimeter in *Rhizophora*, over 0.8 centimeter in *Bruguiera*, and 0.3 centimeter in *Ceriops*).

Key to the genera of Philippine Rhizophoræ.

1. Wood usually with a conspicuous silvery grain on the radial surface; pores barely visible to the naked eye, 90 to 120 microns in diameter, 12 to 40 per square millimeter; parenchyma paratracheal (very rarely paratracheal-zonate) and metatracheal; fibers septate or nonseptate; largest rays over 5,000 microns in height .... 2.
1. Wood usually without conspicuous silvery grain on radial surface; pores not visible to the naked eye, 50 to 70 microns in diameter, 20 to 70 per square millimeter; parenchyma paratracheal, paratracheal-zonate, and scattered; fibers nonseptate; largest rays under 3,000 microns in height .... *Ceriops.*
   2. Growth rings absent; pores mostly solitary; fibers 1,200 to 2,200 microns long; rays 1- to 4- (mostly 3-) seriate, the largest up to 10,000 plus microns in height .... *Rhizophora.*
   2. Growth rings present but scarcely distinct; pores mostly in radial groups of 2 to 6 or in small nests; fibers 850 to 1,600 microns long; rays 2- to 8-seriate, the largest up to 8,000 microns in height .... *Bruguiera.*

Genus BRUGUIERA Lamarck

This genus consists of about seven species of trees and large shrubs which are confined to the mangrove forests of the Old World.

In the Philippines, *Bruguiera* is represented by four species. The wood is characterized as follows: Light brown to orange red, often without distinct heartwood; dull; hard and heavy; straight grained and with conspicuous silvery grain on the radial surface; fine textured. Growth rings usually present but inconspicuous. Pores arranged in short radial groups, 12 to 30 per square millimeter, barely visible to the naked eye, often with a uniseriate sheath of parenchyma; vessel segments tailed, 500 to 1,200 microns long, 90 to 100 microns in diameter, with scalariform perforations and numerous, scalariform intervessel pits. Paren-

chyma paratracheal and metatracheal, generally invisible at low magnifications. Fibers libriform, aligned in radial rows, septate or nonseptate, often plugged with light brown gummy infiltration. Rays numerous, plainly visible to the naked eye, forming conspicuous fleck on the radial surface, 2- to 8-seriate, up to 8,000 plus microns in height, homogeneous or heterogeneous; cells with numerous crystals and copious gummy infiltration.

Key to the species of Bruguiera Lamarck.

1. Wood light brown; largest rays 8,000 plus microns in height; fibers libriform .... *B. parviflora.*
1. Wood dark reddish brown; largest rays 4,000 plus microns in height; fibers semilibriform to libriform........ 2.
   2. Vessels 12 to 16 per square millimeter........ *B. sexangula.*
   2. Vessels 20 to 40 per square millimeter. *B. conjugata* and *B. cylindrica.*

BRUGUIERA CONJUGATA (Linn.) Merr. Plate 9.[17]

Common name.—Busáin.

Local names.—Potótan (Mindoro, Bataan, Tayabas, Negros, Leyte, Zamboanga, Basilan, and Cagayan); busai-ing (Tayabas); bakáu (Tinago Island, Negros, and Zambales); bakáuan (Mindoro); busi-ing (Mindoro); busain or similar forms (Mindoro and Tayabas).

General description of the wood.—Sapwood several centimeters thick; heartwood dark reddish brown, with irregular dark streaks, often lighter and then scarcely distinguishable from the sapwood; wood dull, smooth to the feel, odorless, very hard, heavy (specific gravity 0.74 to 0.94), straight grained, very fine textured. Growth rings present but inconspicuous. Pores evenly distributed, arranged in short radial groups, small, barely visible to the naked eye (appearing as white dots); vessel lines blackish from included infiltration, relatively inconspicuous. Parenchyma indistinct. Rays numerous, visible to the naked eye; ray fleck high, conspicuous. Ripple marks absent.

MINUTE ANATOMY

Vessels solitary, in short radial groups of 2 to 6, or in small nests (mostly in radial groups), with a 1- to 2-seriate sheath of parenchyma which is often interrupted by rays contiguous to the vessel, 28 to 35 per square millimeter; orifices round or oval,

[17] *Literature.*—Brown, 1:52; Foxworthy, Philip. Journ. Sci. 527; Bull. Govern. British North Borneo 32; Malayan Sci. Bull. 133; Whitford, 2:82; Gamble, (1922) 334; Koorders and Valeton, 4:292–295; Heyne, 3 (1913–1917) 351; Troup, 2:503; Moll and Janssonius 3:344; Ridley, 1:695; Hooker, 1:437; Heyne 2 (1927) 1163–1171; Den Berger, 138; Merrill, 3:146.

the largest 100 to 120 microns in diameter; vessel segments 500 to 1,000 microns long, tailed; lateral walls 3 to 5 microns thick; perforations scalariform (8 to 10 bars), oblong, oblique; intervessel pits very numerous, scalariform, extending the full width of the vessel, with very narrow orifices; pits leading to rays, in 2 to 4 rows per cell, oblong or scalariform, several often confluent; tyloses not abundant; black gummy infiltration occasional.

Parenchyma paratracheal and metatracheal, in cambiform rows of 4 to 8 units along the grain; (*a*) paratracheal parenchyma abundant, forming an uninterrupted 1- to 2-seriate sheath; cells medium thick walled, 40 to 160 microns long, 24 to 32 microns in diameter; dark brown gummy infiltration abundant; crystals not observed; starch deposits wanting; (*b*) metatracheal parenchyma sparse, largely restricted to the proximity of the vessels; cells similar to those of the *a* parenchyma.

Fibers libriform, arranged in radial rows, septate or nonseptate, 1,200 to 1,500 microns in diameter, rounded in the cross section, 25 to 32 microns in diameter; lateral walls 6 to 9 microns thick; lumina narrow, plugged with light brown gummy infiltration; interfiber pits simple, rounded, more abundant on the radial walls.

Rays 6 to 8 per millimeter, separated by 2 to 10 fibers, 2- to 6-seriate, homogeneous or heterogeneous; the largest 80 microns wide, and 80 plus cells and 2,500 plus microns in height; "horizontal" cells round or oval (*t*), 100 to 140 microns long, 16 to 28 microns wide, 20 to 35 microns high; "upright" cells (when present) marginal or interspersed, 60 to 120 microns long, 16 to 28 microns wide, 35 to 50 microns high; pits leading to contiguous vessels in 2 to 4 rows per cell, oblong or scalariform, several often confluent; dark reddish brown and light yellow gummy infiltration abundant; crystals numerous; starch deposits not observed.

Material.—Block 13531 B. F., Zamboanga (2 samples).

Uses.—Firewood, constructions, furniture, and piling.

BRUGUIERA CYLINDRICA (Linn.) Blume. Plate 10.[14]

Common name.—Potótan-laláki.

Local names.—Bakáuan (Mindoro); biús (Cotabato); busáin (Mindoro); hiñgáli (Negros); lañgárai (Cotabato); magtoñgóg

[14] *Literature.*—Brown, 1:54; Schneider, 180; Foxworthy, Malayan Sci. Bull. 88; Philip. Journ. Sci. 527; Foxworthy and Matthews, 5; Whitford, 2:82; Gamble, (1922) 334; Koorders and Valeton, 4:298–300; Heyne, 3 (1913–1917) 350; Kanehira, (1921) 108; Troup, 2:504; Moll and Janssonius, 3:343; Ridley, 1:695; Hooker, 2:438; Merrill, 3:147; Den Berger, 138.

(Masbate); potótan and potótan-laláki (Tayabas and Mindoro); tañgal-babáe (Mindoro); kalapínai (La Union); buis (Moro); tañgálan (Mindoro); biuis (Pangasinan); magtañgúd (Masbate); biuas (Bataan).

General description of the wood.—Sapwood whitish to light brown; heartwood dark reddish to grayish brown; wood dull, smooth to the feel, odorless, hard, heavy (specific gravity 0.81 to 0.89), straight grained and with conspicuous silver grain on the radial section, fine textured, working smooth under sharp tools. Growth rings distinct. Pores somewhat crowded at the end of the growth ring, solitary and in short radial groups, small, barely visible to the naked eye (appearing as white dots), often occluded with lustrous infiltration; vessel lines inconspicuous. Parenchyma indistinct. Rays numerous, distinctly visible to the naked eye; ray flecks high, conspicuous. Ripple marks absent.

MINUTE ANATOMY

Growth rings usually marked by a narrow denser zone consisting of thicker-walled fibers and smaller scattered vessels, followed by thinner-walled fibers and several rows of somewhat larger and crowded vessels at the beginning of the next ring.

Vessels solitary, in short radial groups of 2 to 6, or in small nests (mostly in radial groups and nests), larger and more numerous at the inception of the ring, reduced in size and scarce toward the outer margin of the ring, with a uniseriate sheath of parenchyma which is frequently interrupted by rays contiguous to the vessel, 20 to 40 per square millimeter; orifices round, oval, or radially flattened, the largest 90 to 100 microns in diameter; vessel segments 500 to 1,200 microns long, tailed or truncate; lateral walls 3 to 5 microns thick; perforations scalariform with 4 to 8 (usually 5) bars, oblique, oblong; intervessel pits scalariform, extending the full width of the vessel; pits leading to rays in 2 to 4 horizontal rows per cell, scalariform to oblong; tyloses sparse; lustrous infiltration frequent.

Parenchyma paratracheal and metatracheal, in cambiform rows of 4 to 8 units along the grain; (*a*) paratracheal parenchyma forming a 1- or 2- (mostly 1-) seriate sheath; cells medium thick walled, 32 to 40 microns in diameter, 40 to 200 microns long, often occluded with dark brown, gummy infiltration; crystals not observed; starch deposits wanting; (*b*) metatracheal parenchyma sparse, restricted for the most part to the proximity of vessels; cells similar to those of *a* parenchyma.

Fibers semilibriform to libriform, arranged in radial rows, septate or nonseptate, 1,200 to 1,600 microns long, 24 to 28 microns in diameter; lateral walls 4 to 8 microns thick; lumina plugged with light brown, gummy infiltration; interfiber pits simple, rounded, more numerous on the radial walls.

Rays 5 or 6 per millimeter, 2- to 7- (mostly 5-) seriate, separated by 2 to 10 fibers, homogeneous or heterogeneous, largest 120 microns wide, and 100 plus cells and 3,100 plus microns high; small rays 35 to 60 microns wide, and 10 to 30 plus cells and 200 to 600 microns in height; "horizontal" cells rounded or oblong (*t*), 20 to 60 microns long, 12 to 24 microns wide, 20 to 30 microns high; "upright" cells marginal and interspersed, 20 to 60 microns long, 12 to 24 microns wide, 30 to 60 microns high; light yellow and black gummy infiltration frequent; crystals numerous; starch deposits not observed.

Material.—Block 5522 T. S., Tayabas.

Uses.—Firewood and piling.

BRUGUIERA SEXANGULA (Lour.) Poir. Plate 11.[16]

Common name.—Potótan.

Local names.—Potótan or putútan (Tayabas, Zamboanga, Mindoro, Masbate, Misamis, Cotabato, and Palawan); tagása (Bataan); busáin, busáing, etc. (Mindoro, Tayabas, Lanao, and Zamboanga); sagása (Cagayan); alai (Palawan); lagásak (Palaui); bakáuan (Manila); sagásak (Palaui Island); langári (Basilan); potótan-babáe (Palawan and Bataan); bakáuan-laláki; kalabayúan (Bataan); balinsaráyan (Tayabas).

General description of the wood.—Sapwood 2 to 4 centimeters thick; heartwood dark reddish brown, frequently with irregular dark streaks, often lighter and then scarcely distinguishable from the sapwood; wood somewhat lustrous, with smooth feel, odorless, hard, heavy (specific gravity 0.86 to 0.91); straight grained and with conspicuous silver grain on the quarter, fine textured. Growth rings present but inconspicuous. Pores evenly distributed, arranged in short radial rows, small, barely visible to the naked eye (appearing as numerous white dots); vessel lines inconspicuous. Parenchyma indistinct. Rays plain-

[16] *Literature.*—Brown, 1:54; Foxworthy, Philip. Journ. Sci. 527; Bull. Govern. British North Borneo 47; Malayan Sci. Bull. 108; Foxworthy and Matthews, 4; Schneider, 180; Whitford, 2:82; Koorders and Valeton, 4:295, 297; Ridley, 1:695; Heyne, 3 (1913–1917) 350; Heyne, 2 (1927) 1165–1170; Troup, 2:503; Solereder, 1:339–343; Moll and Janssonius, 3:339; Hooker, 2:438; Den Berger, 138; Merrill, 3:147.

ly visible to the naked eye; ray fleck high, conspicuous. Ripple marks absent.

MINUTE ANATOMY

Growth rings ill defined, demarked by a narrow, denser, sinuate zone, consisting of several rows of somewhat radially flattened fibers and devoid of or with few vessels.

Vessels solitary, in short radial rows of 2 to 4, or in small nests (mostly in radial rows), with a 1- or 2-seriate sheath of parenchyma which is often interrupted by rays contiguous to the vessel, 12 to 16 per square millimeter; orifices round or oval, the largest 90 to 100 microns in diameter; vessel segments 350 to 1,000 microns long, tailed or truncate; lateral walls 3 to 5 microns thick; perforations scalariform, with 8 to 10 bars, oblique, oblong; intervessel pits numerous, scalariform, extending the full width of the vessel, with very narrow orifices; pits leading to contiguous rays in 2 or 3 horizontal rows per cell, oblong, elliptical, or scalariform; tyloses not observed; gummy infiltration sparse.

Parenchyma paratracheal and metatracheal, in cambiform rows of 6 to 8 units along the grain; (*a*) paratracheal parenchyma abundant, in a 1- or 2-seriate sheath; cells 40 to 160 microns long, 16 to 36 microns in diameter; gummy infiltration sparse; crystals not observed; starch deposits absent; (*b*) metatracheal parenchyma sparse; cells restricted to the proximity of the vessels, usually solitary, similar to those of the *a* parenchyma.

Fibers semilibriform to libriform, arranged in somewhat indefinite radial rows, septate or nonseptate, 850 to 1,500 microns long, 24 to 30 microns in diameter; lateral walls 4 to 8 microns thick; lumina occasionally plugged with light brown gummy infiltration; interfiber pits simple, round, very numerous on the radial and sparse on the tangential walls.

Rays 7 to 8 per millimeter, separated by 2 to 16 fibers, 2- to 8- (mostly 4- to 6-) seriate, heterogeneous; the largest 120 microns wide, and 80 plus cells and 1,600 plus microns in height; "upright" cells marginal and interspersed (mostly marginal), 30 to 60 microns long, 12 to 24 microns wide, 30 to 40 microns high; "horizontal" cells round (*t*) 30 to 80 microns long, 12 to 24 microns wide, 12 to 30 microns high; pits leading to vessel segments in 2 or 3 horizontal rows per cell, oblong, elliptical, or scalariform; light brown or black gummy infiltration frequent; crystals numerous; starch deposits absent.

Material.—(1) Block 6313 B. F., Bataan; (2) Kuala Lumpur, Federated Malay States, F. W. Foxworthy; (3) 7488 B. F., Palawan.

Uses.—Used principally for firewood; where the tree attains sufficient size, the wood is used for salt-water and foundation piling, mine timbers, house posts, furniture, and cabinet work.

BRUGUIERA PARVIFLORA (Roxb.) W. and A. Plate 12.[14]

Common name.—Lañgárai.

Local names.—Potótan (Tayabas, Cagayan, and Zamboanga); hañgálai or hañgárai (Mindoro, Masbate, Leyte, Iloilo, and Negros); hiñgálai (Polillo); lañgárai or lañgári (Zamboanga, Tayabas, Masbate, Negros, and Zambales); bakáuan-laláki (Batangas); bubutígan, biósan (Samar).

General description of the wood.—Heartwood lacking; wood light brown-yellow (lighter than the other *Bruguiera* species), dull, smooth to the feel, odorless, hard, heavy (specific gravity 0.88 to 0.93), straight grained and with conspicuous silver grain on the quarter, fine textured. Growth rings present but indistinct. Pores evenly distributed, arranged in short radial groups, small (appearing as faint, white dots to the naked eye); vessel lines not distinct. Parenchyma indistinct. Rays numerous, plainly visible to the naked eye; ray fleck high, conspicuous. Ripple marks absent.

MINUTE ANATOMY

Vessels solitary, in radial groups of 2 to 6, or occasionally in small nests (usually in radial groups), with a uniseriate sheath of parenchyma which is often interrupted by rays contiguous to the vessel, 25 to 30 per square millimeter; orifices round or oval, the largest 90 to 100 microns in diameter; vessel segments 500 to 900 microns long, tailed; lateral walls 4 to 6 microns thick; perforations scalariform, oblique, oblong; intervessel pits scalariform, extending the full width of the vessel; pits leading to rays in 2 or 3 rows, oblong to scalariform; tyloses sparse; gummy infiltration not observed.

[14] *Literature.*—Brown, 1:58; Schneider, 181; Foxworthy, Bull. Govern. British North Borneo 25; Philip. Journ. Sci. 527; Malayan Sci. Bull. 106; Foxworthy and Matthews, 5; Whitford, 2:82; Heyne, 3 (1913–1917) 332; Koorders and Valeton, 4:297; Troup, 2:504; Moll and Janssonius, 3:345; Ridley, 1:695; Hooker, 2:438; Heyne, 2 (1927) 1172; Den Berger, 138; Merrill, 3:147.

Parenchyma paratracheal and metatracheal, in cambiform rows of 4 to 12 (mostly 8) units along the grain; (*a*) paratracheal parenchyma forming an uniseriate sheath; cells medium-thick walled, 40 to 80 microns long, 20 to 40 microns in diameter; globules of light brownish gummy infiltration frequent; crystals not observed; starch deposits sparse; (*b*) metatracheal parenchyma sparse, usually restricted to the proximity of the vessels; cells similar to those of the *a* parenchyma.

Fibers libriform, arranged in radial rows, septate or nonseptate, 1,000 to 1,400 microns long, 20 to 30 microns in diameter; lateral walls 7 to 10 microns thick; lumina very small, occasionally plugged with light brown gummy infiltration; interfiber pits round, simple, more abundant on the radial walls.

Rays 6 to 7 per millimeter, separated by 3 to 10 fibers, 2- to 8-seriate, homogeneous or heterogeneous; the largest 140 microns wide, and 200 plus cells and 8,000 plus microns high; "horizontal" cells rounded (*t*), 60 to 90 microns long, 10 to 28 microns wide, 12 to 24 microns high; "upright" cells (when present) 20 to 60 microns long, 10 to 28 microns wide, 24 to 40 microns high; pits leading to vessels in 2 or 3 horizontal rows, oblong to scalariform; light brown or black gummy infiltration frequent; crystals numerous; starch deposits sparse.

Material.—Block 5523 T. S., Tayabas.

Uses.—Firewood and pilings.

Genus CERIOPS Arnott

This genus consists of 7 species of trees and shrubs, all confined to the mangrove forests of the Tropics. *Ceriops tagal* (Perr.) C. B. Rob. and *C. roxburghiana* Arn. occur in the Philippines.

The woods of this genus are characterized as follows: Yellowish to orange-red, without distinct heartwood; dull; hard and heavy; straight grained, very fine textured. Growth rings present but inconspicuous. Pores numerous, evenly distributed, arranged in short radial rows, 25 to 70 per square millimeter, invisible without a 10x hand lens, with a uniseriate sheath of parenchyma, several often united by a 2- to 4-seriate, broken band of zonate parenchyma; vessel segments tailed, 450 to 800 microns long, 50 to 70 microns in diameter with scalariform perforations and numerous scalariform intervessel pits. Parenchyma paratracheal, paratracheal-zonate, and metatracheal, invisible at low magnification. Fibers libriform, fine, arranged

in somewhat indefinite radial rows, nonseptate, plugged with light brownish gummy infiltration. Rays visible to the naked eye (distinctly of two sizes in *C. roxburghiana*), the largest 2,000 plus microns in height, homogeneous or heterogeneous; cells with numerous crystals and copious gummy infiltration.

Key to the species of Ceriops Arnott.

1. Vessels 50 to 70 per square millimeter, the largest 50 to 60 microns in diameter; fibers 16 to 20 microns in diameter; rays 1- to 10-seriate, distinctly of two sizes; large rays plainly visible to the naked eye; small rays fine, 1- to 2-seriate, not visible without a 10x hand lens. *C. roxburghiana.*
1. Vessels 25 to 30 per square millimeter, the largest 60 to 70 microns in diameter; fibers 24 to 28 microns in diameter; rays 1- to 5-seriate, of nearly uniform size, visible to the naked eye.......................... *C. tagal.*

CERIOPS ROXBURGHIANA Arn. Plate 13.[17]

Common name.—Tañgál.

Local names.—Matañgál (Bataan); tañgál (Tayabas and Camarines); tañgung (Surigao); bakáuan (Bataan and Mindoro); bulubadiáng (Panay); tuñgúg (Negros).

General description of the wood.—Sapwood narrow; heartwood yellowish red to orange-red, changing on exposure to reddish brown, the decoction fluorescent (orange-red); wood dull, smooth to the feel, odorless, hard, heavy (specific gravity 0.88 to 1.07); straight grained, very fine textured, working to a very smooth surface under sharp tools. Growth rings present but inconspicuous. Pores numerous, evenly distributed, very small, invisible without a hand lens, solitary or arranged in short radial groups; vessel lines inconspicuous. Parenchyma in rather poorly defined, concentric lines connecting the vessels. Rays of two sizes, the larger plainly visible to the naked eye, the finer numerous and not visible without a hand lens; ray fleck medium high, of about the same color as, or somewhat lighter than, the background, inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Vessels solitary, in radial groups of 2 to 5, or in small nests (mostly in radial groups), with a uniseriate sheath of paren-

[17] *Literature.*—Brown, 1:60; Foxworthy, Philip. Journ. Sci. 527; Foxworthy and Matthews, 47; Schneider, 181; Koorders and Valeton, 4:287–289; Gamble, 334; Troup, 2:501; Hooker, 2:436; Heyne, 2 (1927) 1167; Den Berger, 140; Merrill, 3:144, 145.

chyma which is frequently interrupted by rays contiguous to the vessel, 2 to many often united by a band of zonate parenchyma, 50 to 70 per square millimeter; orifices round or oblong, the largest 50 to 60 microns in diameter; vessel segments 500 to 800 microns long, tailed; lateral walls 3 to 4 microns thick; perforations scalariform with 6 to 8 bars, elliptical, oblique; intervessel pits scalariform, extending the full width of the vessel, with very narrow orifices; pits leading to rays oblong, elliptical, or scalariform, several often confluent; tyloses present; gummy infiltration not observed.

Parenchyma paratracheal, paratracheal-zonate, and metatracheal, in cambiform rows of 4 to 6 units along the grain; (*a*) paratracheal parenchyma abundant, forming a uniseriate, often uninterrupted sheath; cells medium thick walled, 60 to 120 microns long, 12 to 20 microns in diameter; gummy infiltration present; crystals not observed, starch deposits wanting; (*b*) paratracheal-zonate parenchyma abundant, extending laterally in 2- to 4-seriate, somewhat broken wavy bands which either end blindly or unite 2 to many vessels; similar to those of the *a* parenchyma; (*c*) metatracheal parenchyma sparse, confined to the proximity of the vessels; cells similar to those of the *a* parenchyma.

Fibers fine, libriform, arranged in somewhat indefinite radial lines, nonseptate, 850 to 1,400 microns long, 16 to 20 microns in diameter; lateral walls 7 to 8 microns thick; lumina very small, plugged with light brown gummy infiltration; interfiber pits sparse, rounded, simple.

Rays 7 to 8 per millimeter, separated by 2 to 8 fibers, 1- to 10-seriate, heterogeneous, of two types; (*a*) large rays 3- to 10-seriate and 100 microns in width, up to 80 plus cells and 2,200 plus microns in height; (*b*) small rays 1- to 3-seriate and 4 to 12 microns in width, 1 to 20 cells and 20 to 500 plus microns in height; ray cells very irregular in shape (*t*); "upright" cells marginal and interspersed, 30 to 40 microns long, 4 to 28 microns wide, 40 to 60 microns high; "horizontal" cells 30 to 60 microns long, 4 to 16 microns wide, 16 to 30 microns high; pits leading to vessels oblong, elliptical, or scalariform, several often confluent; globules of light yellow or occasionally black infiltration frequent; crystals numerous; starch deposits not observed.

Material.—Block 5524 T. S., Tayabas.

Uses.—Similar to those of *Ceriops tagal.*

CERIOPS TAGAL (Perr.) C. B. Rob. Plate 14.[19]

Common name.—Tañgál.

Local names.—Tañgál (Tagalog, Bisaya, Zambales, and Zamboanga); tuñgód (Visayan in Negros); tañghál (Mindoro); magtoñgód (Mindoro); tañgál-lalaki (Mindoro); tuñgúd (Jolo); toñgóg (Masbate); tagása (Bataan); pakat (Palawan); tanggui (Culion); tuñgog (Visayan); róñgon (Zambales); rúñgon (Pangasinan).

General description of the wood.—Sapwood narrow; heartwood yellowish to orange-red, changing on exposure to reddish brown; decoction fluorescent (orange-red); wood dull, smooth to the feel, odorless, hard, heavy (specific gravity 0.88 to 1.07), straight grained, very fine textured, working to a very smooth surface under sharp tools. Growth rings present but scarcely distinct. Pores numerous, evenly distributed, solitary and in short radial groups, small, invisible without a hand lens; vessel lines indistinct. Parenchyma forming rather poorly defined, broken, wavy, concentric lines uniting the vessels. Rays numerous, medium fine, visible to the naked eye; ray fleck medium high, somewhat lighter in color than the background, silvery but relatively inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Vessels solitary, in short radial rows of 2 to 4, or in small nests (mostly in radial groups), with a uniseriate sheath of parenchyma, which is frequently interrupted by rays contiguous to the vessel, often united by bands of paratracheal-zonate parenchyma, 25 to 30 per square millimeter; orifices oval, the largest 60 to 70 microns in diameter; vessel segments 450 to 700 microns long, tailed; lateral walls 4 to 5 microns thick; perforations scalariform with 4 to 8 (usually 5) bars, elliptical, oblique; intervessel pits scalariform, usually extending the full width of the vessel, with very narrow orifices; pits leading to rays simple, oblong or scalariform; tyloses abundant; black gummy or light yellow granular infiltrations frequent.

Parenchyma paratracheal, paratracheal-zonate, and metatracheal, in cambiform rows of 6 to 8 units along the grain; (*a*)

[19] *Literature.*—Brown, 1:60; Schneider, 181; Foxworthy, Malayan Sci. Bull. 130; Philip. Journ. Sci. 528; Bull. Govern. British North Borneo 47; Foxworthy and Matthews, 4; Whitford, 2:82; Heyne, 3 (1913–1917) 346–348; Gamble, 333; Koorders and Valeton, 4:284–287; Hooker, 2:436; Merrill, 3:144, 145.

paratracheal parenchyma abundant, in a uniseriate layer which frequently encircles the vessel; cells medium thick walled, 30 to 32 microns wide, 40 to 60 microns long; gummy infiltration present; crystals not observed; starch deposits wanting; (*b*) paratracheal-zonate abundant, extending laterally in short 2- to 4-seriate, broken, wavy bands which either end blindly or unite several vessels; cells similar to those of the *a* parenchyma; (*c*) metatracheal parenchyma sparse, usually confined to the proximity of the vessels; cells similar to those of the *a* parenchyma.

Fibers fine, libriform, aligned in somewhat inconspicuous radial rows, nonseptate, 1,000 to 1,500 microns long, 24 to 28 microns in diameter; lateral walls 8 to 10 microns thick; lumina very small, plugged with light brown infiltration; interfiber pits very sparse, rounded, simple.

Rays 8 to 9 per millimeter, separated by 2 to 12 fibers, 1- to 5-seriate, heterogeneous, up to 70 microns in width, and 80 plus cells and 1,800 plus microns in height (uniseriate rays approximately 16 microns wide and 400 microns in height); "upright" cells marginal and interspersed, 40 to 80 microns long, 16 to 24 microns wide, 30 to 60 microns high; "horizontal" cells oval (*t*), 40 to 100 microns long, 16 to 24 microns wide, 20 to 30 microns high; pits leading to vessels simple, oblong to scalariform; globules of dark brown, gummy infiltration abundant; crystals numerous; starch deposits not observed.

Material.—(1) 444 M. P., Palawan; (2) Kuala Lumpur, Federated Malay States, F. W. Foxworthy.

Uses.—High-grade firewood; pilings, also roof supports, etc.; shipbuilding. A yellowish red dye is obtained from tangal wood and the bark is an important source of tanning materials.

Genus RHIZOPHORA Linnæus

This genus is represented in the Tropics of both hemispheres and consists of eight species, all confined to mangrove swamps. *Rhizophora apiculata* Blume and *R. mucronata* Lam. are found in the Philippines.

The wood of *Rhizophora* is characterized as follows: Sapwood light yellowish brown to grayish brown, 3 to 5 centimeters thick; heartwood orange-red to chocolate-brown; wood dull, hard and heavy, straight or shallowly interlocked grained and frequently with conspicuous silvery grain on the quarter, fine textured. Growth rings wanting. Pores visible to the naked eye, numerous, usually solitary, 20 to 30 per square millimeter,

with a 1- or 2-seriate sheath of parenchyma; vessel segments tailed, 500 to 1,200 microns long, 90 to 100 microns in diameter, with scalariform perforations and numerous, scalariform intervessel pits. Parenchyma paratracheal and metatracheal, invisible at low magnification. Fibers libriform, aligned in somewhat irregular radial rows, septate or nonseptate, often plugged with light brown gummy infiltration. Rays numerous, plainly visible to the naked eye, 1- to 4-seriate, the largest up to 1 plus centimeter in height, homogeneous or heterogeneous; ray cells frequently crystalliferous, many with copious dark brown gummy infiltration.

RHIZOPHORA MUCRONATA Lam. Plate 15.[10]

Common name.—Bacáuan-babáe.

Local names.—Bakáuan (Tagalog); bakháu (Surigao); bakáu (Negros); bakáuang-laláki (Zamboanga); bangkáu (Tagalog in Tayabas).

General description of the wood.—Sapwood light yellowish brown to grayish brown, 3 to 5 centimeters thick; heartwood orange-red; wood dull to somewhat lustrous, smooth to the feel, odorless, hard, heavy (specific gravity 0.77 to 1.13), straight or broadly and shallowly interlocked grained, and with conspicuous silvery grain on the quarter, fine textured. Growth rings absent. Pores fairly numerous, evenly distributed, mostly solitary, small (barely visible to the naked eye as small, white specks); vessel lines distinct, somewhat darker in color than the background, owing to infiltration. Parenchyma indistinct. Rays visible to the naked eye, numerous, straight, ray fleck reddish brown, very high and forming a conspicuous silvery grain against the background of fibrous tissue. Ripple marks absent.

MINUTE ANATOMY

Vessels evenly distributed, mostly solitary, occasionally in radial groups or small nests, encircled by a 1- or 2-seriate sheath

[10] *Literature.*—Brown, 1:68; Schneider, 182; Foxworthy, Philip. Journ. Sci. 526–528; Bull. Govern. British North Borneo 23; Malayan Sci. Bull. 85; Foxworthy and Matthews, 3; Whitford, 2:85; Heyne, 3 (1913–1917) 344, 348, 349; 2 (1927) 1169; Gamble, 335; Koorders and Valeton, 4:278–282; Boulger, 241; Kanehira, (1921) 109; Troup, 2:500; Ridley, 1:693; Hooker, 2:435; Merrill, 3:145; Den Berger, 141; Engler and Prantl, 3, 7 (1898) 44; Holtermann, Der Einfluss des Klimas auf den Bauder Pflanzengewebe (1907), 68, 194; Nördlinger, 4 (1877) 25; Sargent, The Woods of the United States (1885) 46 (as *R. mangle*); Moll and Janssonius, 3:533.

of parenchyma which is frequently interrupted by rays contiguous to the vessel, 20 to 30 per square millimeter; orifices round or oval (mostly round), the largest 90 to 100 microns in diameter; vessel segments 600 to 1,200 microns long, usually with long-attenuate tails; lateral walls 4 to 5 microns thick; perforations scalariform with 5 to 10 (mostly 5) bars, elliptical, oblique; intervessel pits very numerous, scalariform, extending the full width of the vessel, with very narrow orifices; pits leading to rays simple, oblong, elliptical or scalariform, several to each cell; tyloses abundant; dark brown infiltration frequent.

Parenchyma paratracheal and metatracheal, in cambiform rows of 4 to 8 (usually 4) units along the grain; (*a*) paratracheal parenchyma abundant, forming a 1- or 2-seriate uninterrupted sheath; cells thick walled, 36 to 40 microns in diameter, 100 to 180 microns long, occluded with light brown gummy infiltration; crystals not observed; starch grains absent; (*b*) metatracheal parenchyma sparse; cells similar to those of the *a* parenchyma.

Fibers libriform, aligned in somewhat irregular radial rows, septate or nonseptate, 1,200 to 1,800 microns long, hexagonal or angular in the cross section and 20 to 30 microns in diameter; lateral walls 8 to 10 microns thick; lumina very small, plugged with brownish gummy infiltration; interfiber pits small, round, simple, more numerous on the radial walls.

Rays 4 or 5 per millimeter, separated by 6 to 12 fibers, 1- to 4-seriate, homogeneous or heterogeneous, of two types; (*a*) large rays 80 microns wide, and up to 120 plus cells and 6 plus millimeters in height; (*b*) small rays 1,000 to 2,000 microns in height; rays of both types (*t*) frequently aligned in longitudinal rows along the grain; "horizontal" cells medium thick walled, oval (*t*), 80 to 120 microns long, 12 to 20 microns wide, 20 to 30 microns high; "upright" cells 40 to 120 microns long, 12 to 20 microns wide, 30 to 40 microns high; pits leading to vessels oblong, elliptical or scalariform, simple, several to each cell; large globules of a light brown infiltration very frequent in the ray tissue; crystals numerous; starch deposits not observed.

Material.—(1) Block 24408 B. F., Agusan, Philippines; (2) Forest Experiment Station, Buitenzorg, Java.

Uses.—The same uses as *R. apiculata* Blume; according to Schneider it is impossible to say which of these two species furnishes the greater bulk of the timber and firewood brought into the market.

RHIZOPHORA APICULATA Blume. Plate 16.[20]

Common name.—Bakáuan-lalaki.

Local names.—Bakáuan (Tagalog); bakáu (Visayan); bakáuan-babáe (Tagalog, Visayan, Zamboanga); uakátan (Mindoro); bakáuan-laláki (Mindanao); bakad (Zambales); bakháu (Samar, Capiz); bakáu-laláki (Pampanga); bangkáu (Davao).

General description of the wood.—Sapwood light yellow, 3 to 5 centimeters thick, in old trees very sharply differentiated from the heartwood; heartwood orange-red to dark chocolate-brown; wood dull, somewhat rough to the feel, odorless, hard, heavy (specific gravity about 0.9), straight or broadly and shallowly interlocked grained and with conspicuous silvery grain on the quarter, fine textured. Growth rings wanting. Pores fairly numerous, evenly distributed, solitary or in short radial groups, round, small (barely visible to the naked eye as numerous white dots); vessel lines distinct, almost black owing to dark gummy infiltration. Parenchyma indistinct. Rays numerous, visible to the naked eye, straight; ray fleck very high, conspicuous, dark brown, forming a conspicuous silvery grain against the background of fibrous tissue. Ripple marks absent.

MINUTE ANATOMY

Vessels evenly distributed, mostly solitary, occasionally in short radial groups of 2 to 4 or in small nests, with a 1- or 2-seriate sheath of parenchyma which is often interrupted by rays contiguous to the vessel, 20 to 25 per square millimeter; orifices round or oblong (mostly round), the largest 90 to 100 microns in diameter; vessel segments 500 to 1,000 microns long, with long attenuate or less frequently short tails; lateral walls 4 to 8 microns thick; perforations scalariform with 4 to 6 bars, elliptical, oblique; intervessel pits very numerous, scalariform, extending the full width of the vessel, with very narrow orifices; pits leading to rays simple, oblong, elliptical or scalariform; tyloses very abundant; dark brown gummy infiltration frequent.

Parenchyma paratracheal and metatracheal, in cambiform rows of 4 to 8 units along the grain; (*a*) paratracheal parenchyma abundant, forming a 1- or 2-seriate sheath; cells thick walled, 80 to 160 microns long, 30 to 40 microns in diameter,

[20] *Literature.*—Foxworthy, Philip. Journ. Sci. 526–528; Bull. Govern. British North Borneo 23; Foxworthy and Matthews, 3; Schneider, 182; Brown, 1:68; Heyne, 3 (1913–1917) 334, 348, 349; Gamble, 333; Ridley, 1:695 (*R. conjugata*); Hooker, 2:436; Merrill, 3:145.

occluded with light brown gummy infiltration; crystals not observed; starch deposits wanting; (*b*) metatracheal parenchyma sparse; cells similar to those of the *a* parenchyma.

Fibers libriform, aligned in radial rows, septate or nonseptate, 1,300 to 2,200 microns long, rounded or hexagonal in the cross section, 28 to 30 microns in diameter; walls 10 to 12 microns thick; lumina very small, plugged with light brown gummy infiltration; interfiber pits simple, round, more numerous on the radial walls.

Rays 5 to 6 per millimeter, separated by 6 to 10 fibers, 1- to 4-seriate, homogeneous or heterogeneous; the largest 55 microns in width and 150 plus cells and 1 plus centimeter in height; aligned in longitudinal rows along the grain (*t*); "horizontal" cells oval, 60 to 80 microns long, 12 to 16 microns wide, 20 to 30 microns high; "upright" cells 40 to 60 microns long, 12 to 16 microns wide, 30 to 50 microns high; pits leading to vessels simple, oblong, elliptical or scalariform; ray cells filled with dark brown or light yellow infiltration; crystals abundant; starch deposits not observed.

Material.—Blocks 5525 T. S., Tayabas; No. 13533 B. F., Zamboanga.

Uses.—Bakauan is the standard firewood of the Philippine Islands. Where the tree attains sufficient size, the wood is used for salt-water and foundation pilings, mine timbers, house posts, furniture and cabinet work; if properly sawn and carefully seasoned it would make excellent flooring.

Remarks.—Very strong and durable, even when submerged in water, qualities that make it highly desirable for foundations; hard to saw but otherwise not difficult to work.

MYRTACEÆ

The myrtle family consists of about 70 genera and 2,800 species of aromatic evergreen shrubs or trees, which are widely distributed in tropical and subtropical regions. *Eucalyptus* L'Hér., with about 300 species which are mostly Australian, is its most important timber-producing genus. The family is represented in the Philippines by many species; most of them are in the genus *Eugenia* (Linn.) Mich.

Genus OSBORNIA F. Mueller

One littoral species, *O. octodonta* F. Muell., is found in the Philippines; this is a small tree occurring on the margins of mangrove swamps and on sandy beaches.

OSBORNIA OCTODONTA F. Muell. Plate 17.[21]

Common name.—Tawalis.

Local names.—Tuawis (Palawan); tiwayos (Masbate); gun-hun (Basilan); maligáng (Polillo); tawalis (Tayabas and Camarines); sagasá (Iloilo); tabáu (Negros); duluk-dúluk and sagasá (Negros); monotbonót (Leyte); kulási (Zamboanga).

General description of the wood.—Sapwood light brown; heartwood dark grayish brown to chocolate-brown; wood somewhat lustrous, smooth to the feel, odorless, hard, heavy (specific gravity about 0.85), narrowly and shallowly interlocked grained, very fine textured, finishing smooth, said to be extremely durable. Growth rings present but indistinct. Pores mostly solitary, very small, invisible to the naked eye, occasionally plugged with lustrous infiltration; vessel lines inconspicuous. Parenchyma indistinct. Rays very numerous, very fine (barely visible with a hand lens); ray fleck very low, about the same color as the background and hence inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Vessels numerous, solitary or occasionally radially or tangentially paired, with contiguous rays on one or both sides, 70 to 90 per square millimeter, orifices elliptical, the largest 50 to 60 microns in diameter; vessel segments 250 to 600 microns long, tailed; lateral walls 3 to 4 microns thick; perforations simple, round, horizontal or occasionally slightly oblique; intervessel pits not numerous, 3 to 5 microns in diameter, round or oblong, with narrow orifices; pits leading to rays simple, 6 to 8 microns in diameter, in 5 or 6 horizontal rows per cell, round, oblong, or elliptical; tyloses sparse; vessels occasionally occluded with light yellow, lustrous infiltration.

Parenchyma paratracheal, metatracheal-zonate, and metatracheal, in cambiform rows of 2 to 5 units along the grain; (*a*) paratracheal parenchyma abundant, never completely encircling the vessel but generally restricted to a group of 2 to many cells on one side; cells medium thick walled (3 to 4 microns), 6 to 24 microns in diameter, 100 to 160 microns long; (*b*) metatracheal-zonate parenchyma abundant, in broken wavy, somewhat rugged 1- to 4-seriate bands; cells similar to those of the *a* parenchyma; (*c*) metatracheal parenchyma abundant, the cells similar to those of the *a* parenchyma; dark gummy infiltration abundant in all types of parenchyma; crystals not observed; starch deposits wanting.

[21] *Literature.*—Brown, 1:72; Merrill, 3:182, 4:89, 130.

Fibers fine, semilibriform to libriform, aligned in radial rows, short (600 to 850 microns), rounded, and 8 to 12 microns in diameter in the cross section; lateral walls 3 to 5 microns thick; lumina plugged with dark-colored infiltration; interfiber pits numerous, round, bordered, 3 to 4 microns in diameter, with narrow, nearly vertical orifices.

Rays very fine, close, 15 to 18 per millimeter, separated by 1 to 5 fibers, 1- or 2- (mostly 1-) seriate, heterogeneous, the largest 12 to 25 microns in width, and 12 plus cells and 350 plus microns in height; "upright" cells marginal for the most part, 20 to 60 microns long, 8 to 16 microns wide, 24 to 40 microns high; "horizontal" cells rounded (*t*), 20 to 60 microns long, 8 to 16 wide, 16 to 20 microns high; pits leading to vessels simple, 6 to 8 microns in diameter, in 5 or 6 horizontal rows per cell, round, oblong, or elliptical; dark-colored gummy infiltration abundant, occluding many cells; crystals not observed; starch grains wanting.

Material.—Block 18816 B. F., Masbate.

COMBRETACEÆ

The white mangrove family consists of about 15 genera and 240 species of trees, shrubs, and herbs, widely distributed throughout the tropical and subtropical regions of the world. Some of the arborescent species are important for their timber, others for their bark, leaves, and fruit which are rich in tannin and dyestuffs. Species of the genera *Terminalia* Linn. and *Lumnitzera* Willd. furnish woods in the Philippines that are of considerable value for general construction, interior finish, and furniture.

Genus LUMNITZERA Willdenow

Two littoral species of *Lumnitzera* occur in the Philippines which produce "tabau wood" in limited quantity. *Lumnitzera* woods are characterized as follows: Yellowish or grayish brown, with a distinct roselike scent when fresh; hard; moderately heavy; fine textured. Pores numerous, evenly distributed (30 to 70 per square millimeter), invisible without a 10x hand lens, encircled by paratracheal parenchyma; vessel segments tailed, 170 to 500 microns long, 60 to 100 microns in diameter, with simple perforations. Parenchyma paratracheal, paratracheal-zonate, and metatracheal, indistinct at low magnifications. Fibers semilibriform to libriform, fine, arranged in radial rows. Rays numerous, very fine (barely visible even with a 10x hand

lens), 1- or 2- (mostly 1-) seriate, up to 14 plus cells in height, homogeneous or heterogeneous.

Key to the species of Lumnitzera Willdenow.

1. Vessels 30 to 45 per square millimeter, the largest 90 to 100 microns in diameter; parenchyma paratracheal and metatracheal; fibers nonlibriform to semilibriform; rays 10 to 14 per millimeter (x), 40 to 60 per square millimeter (t) .... *L. littorea.*
1. Vessels 60 to 70 per square millimeter, the largest 60 to 70 microns in diameter; parenchyma paratracheal, paratracheal-zonate, metatracheal-zonate, and metatracheal; fibers semilibriform to libriform; rays 14 to 18 per millimeter (r), 80 to 100 per square millimeter. *L. racemosa.*

LUMNITZERA LITTOREA (Jack) Voigt. Plate 18.[22]

Common name.—Tabáu.

Local names.—Batíng or baktíng (Tawitawi and Jolo); dalúru-babáe (Tayabas); sagása' (Dinagat); maóro (Surigao); kolasíman (Culion); libáto (Tayabas, Polillo, and Palawan); panting-pantíng (Basilan); kalapíni (Zambales); karifurúg (Cagayan); kulási (Mindoro); bulokbúlok and sala'sá (Occidental Negros); agnáia (Zambales); anilái (Mindoro); papásil (Tayabas); magalolo (Polillo); santíng (Moro and Tawitawi); tabáu (Capiz, Negros, Zamboanga, Sorsogon, and Masbate); dulokdúlok (Masbate).

General description of the wood.—Distinct heartwood wanting; wood grayish brown to yellowish brown with a reddish tinge, becoming lighter on exposure to the air, with a distinct roselike scent when fresh cut, lustrous, smooth to the feel, hard, moderately heavy (specific gravity 0.60 to 0.68), very strong and durable, straight grained, fine textured, surfacing to a silky finish under sharp tools. Growth rings distinct but not prominent, irregular. Pores numerous, evenly distributed, arranged in radial rows of 2 to many, small, invisible without a 10x hand lens, often occluded with white, chalky deposits or lustrous infiltration; vessel lines inconspicuous. Parenchyma indistinct. Rays numerous, very fine (barely visible with a 10x hand lens); ray fleck low, reddish brown, inconspicuous. Ripple marks absent.

[22] *Literature.*—Brown, 1:68; Foxworthy, Philip. Journ. Sci. 529; Bull. Govern. British North Borneo 12, 27; Malayan Sci. Bull. 131; Foxworthy and Matthews, 7; Schneider, 183; Whitford, 2:87; Kanehira, (1924) 31, 62, 69; Koorders and Valeton, 9:31–33; Heyne, 3 (1913–1917) 359; 2 (1927) 1179; Merrill, 3:153; Hooker, 2:451.

MINUTE ANATOMY

Growth rings demarked by a darker zone of denser tissue composed of somewhat radially flattened fibers and crowded, smaller vessels, followed by larger vessels in the next ring.

Vessels mostly in radial rows of 2 to 8, somewhat larger at the beginning of the ring, gradually reduced in size and more crowded toward the outer margin (especially in the narrow zone demarking the seasonal ring), with a 1- or 2-seriate sheath of parenchyma which is frequently interrupted by rays contiguous to the vessel, 30 to 45 vessels per square millimeter; orifices round to oval, the largest 90 to 100 microns in diameter; vessel segments storied, 250 to 525 microns long, with short, blunt, or long-attenuate tails; lateral walls 3 to 5 microns thick; perforations simple, circular, horizontal or slightly oblique; intervessel pits numerous, crowded, 4 to 5 microns in diameter, rounded, with narrow orifices; pits leading to rays numerous to each ray cell, usually in 4 or 5 horizontal rows, simple or bordered, rounded, with narrow orifices; tyloses sparse; white chalky deposits sparse.

Parenchyma paratracheal and metatracheal, in cambiform rows of 2 to 4 units along the grain; (*a*) paratracheal parenchyma abundant, forming a 1- or 2-seriate sheath; cells medium thick walled, 16 to 32 microns in diameter, 40 to 160 microns long; (*b*) metatracheal parenchyma sparse; cells similar to those of the paratracheal parenchyma; dark brown gummy or light yellow granular infiltration very abundant in both types of parenchyma, occluding most of the cells; crystals not observed; starch deposits absent.

Fibers fine, nonlibriform to semilibriform, aligned in radial rows, somewhat thicker walled and radially flattened toward the outer margin of the ring, 20 to 24 microns in diameter, 500 to 1,200 microns long; lateral walls 3 to 5 microns thick; interfiber pits sparse, rounded, simple or bordered, with slitlike, nearly vertical orifices; infiltration not observed.

Rays very fine, close (10 to 14 per millimeter), 40 to 60 per square millimeter (*t*), separated by 1 to 8 fibers, 1- or 2- (mostly 1-) seriate, homogeneous or rarely heterogeneous, the largest 16 to 20 microns in width, and 10 plus cells and 350 plus microns in height; "horizontal" cells 100 to 140 microns long, 12 to 20 microns wide, 16 to 24 microns high; "upright" cells strictly marginal, 40 to 100 microns long, 12 to 20 microns wide, 24 to 36 microns high; pits leading to vessels numerous, usually in 4 or 5 horizontal rows, simple or bordered, rounded, with

narrow orifices; cells occluded with dark gummy, or yellowish granular infiltration; crystals not observed; starch deposits absent.

Material.—Block 5674 T. S., Tayabas.

Remarks.—Wood very strong and extremely durable, and hence much prized for piling, for which purpose it is used with the bark attached; seasons well, keeps its shape even when exposed to severe weather conditions, and easy to work.

Uses.—Piles, poles, house posts, ties, paving blocks, bridges, wharves, in general for heavy construction, ship planking and decks, handles, and cabinet work.

LUMNITZERA RACEMOSA Willd. Plate 19.[28]

Common name.—Kulási'.

Local names.—Tabáu (Iloilo, Tayabas); sulási' (Rizal, Manila); kulási' (Bataan).

General description of the wood.—Heartwood wanting; wood dark grayish brown, somewhat lustrous, smooth to the feel, odorless, hard, medium heavy (specific gravity about 0.65), straight grained, very fine textured, finishing smooth. Growth rings distinct but not prominent. Pores numerous, evenly distributed, arranged in radial lines, small (invisible without a 10x hand lens); vessel lines inconspicuous. Parenchyma indistinct. Rays numerous, very fine (barely visible with a 10x hand lens); ray fleck very low, about the same color as the background and hence inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Growth rings demarked by a narrow darker zone composed of several rows of thicker walled, somewhat radially flattened fibers and quite devoid of vessels, followed by larger vessels in the next ring.

Vessels solitary, in radial groups of 2 to 7, or in small nests, somewhat larger at the beginning of a growth ring, usually solitary and reduced in size toward the outer margin, and generally wanting in the narrow zone demarking the ring, with a 1- or 2-seriate sheath of parenchyma which is often interrupted by rays contiguous to the vessel, 60 to 70 per square millimeter; orifices round or oval, the largest 60 to 70 microns

[28] *Literature.*—Brown, 1:70; Schneider, 183; Foxworthy, Philip. Journ. Sci. 529; Foxworthy and Matthews, 7; Gamble, 348; Koorders and Valeton, 9:33; Whitford, 2:87; Kanehira, (1921) 109; Troup, 2:548; Moll and Janssonius, 3:382; Hooker, 2:452; Lecomte, 165; Merrill, 3:154; Heyne, 2 (1927) 1178.

in diameter; vessel segments storied, 170 to 500 microns long, with long-attenuate tails; lateral walls 4 to 5 microns thick; perforations simple, circular, horizontal or slightly oblique; intervessel pits numerous, crowded, 4 to 5 microns in diameter, round or oblong, with narrow orifices; pits leading to rays in 3 to 5 horizontal rows per cell, bordered, large, 5 to 7 microns in diameter, round or oblong, with narrow orifices; tyloses sparse; white chalky deposits occasionally present.

Parenchyma paratracheal, paratracheal-zonate, metatracheal-zonate, and metatracheal, in cambiform rows of 2 to 4 units along the grain; (*a*) paratracheal parenchyma abundant, forming a 1- or 2-seriate sheath; cells thick walled, 20 to 28 microns in diameter, 80 to 160 microns in length; (*b*) paratracheal-zonate parenchyma abundant, in short, 1- to 3-seriate bands uniting the vessel to proximate rays or occasionally extending across the rays and joining several vessels; (*c*) metatracheal-zonate parenchyma in short, broken, 1- to 3-seriate bands uniting 2 to several rays; cells similar to those of the paratracheal parenchyma; (*d*) metatracheal parenchyma abundant, the cells solitary or in small groups but otherwise similar to those of the paratracheal parenchyma; infiltration absent in all types of parenchyma; crystals not observed; starch deposits very sparse.

Fibers fine, semilibriform to libriform, arranged in radial lines, 18 to 20 microns in diameter, 500 to 1,000 microns long; walls 4 to 6 microns thick; interfiber pits very sparse, minute, round, bordered, with slitlike nearly vertical orifices, dark infiltration sparse.

Rays very fine, close (14 to 18 per millimeter), 80 to 100 per square millimeter (*t*), 1- or 2- (mostly 1-) seriate, homogeneous or occasionally heterogeneous, the largest 30 to 32 microns in width, and up to 14 plus cells and 425 plus microns in height; "horizontal" cells 60 to 80 microns long, 12 to 16 microns wide, 20 to 30 microns high; "upright" cells marginal and interspersed, 40 to 60 microns long, 12 to 16 microns wide, 30 to 40 microns high; pits leading to vessels in 3 to 5 horizontal rows per cell, large, 5 to 7 microns in diameter, round or oblong, bordered, with narrow orifices; dark brown, gummy or light yellow, granular infiltrations copious, occluding most of the ray cells; crystals wanting; starch deposits not observed.

Material.—Block 17334 B. F., Iloilo.

Uses.—Important only for firewood; but sometimes used for house posts.

MYRSINACEÆ

This family includes more than 30 genera and 350 species of trees, shrubs, and a few climbers, confined to tropical and subtropical regions. Taken as a whole the family is not important in timber production.

Genus AEGICERAS Gaertner

This genus is represented in the Philippines by two species of glabrous shrubs or small trees, which border sluggish streams in the interior of mangrove swamps.

The woods of *Aegiceras* are characterized as follows: Dark grayish brown and often oily; moderately hard; moderately heavy; straight grained; fine textured. Pores extremely numerous (80 to 250 per square millimeter), arranged in radial rows of 2 to 8, invisible without a 10x hand lens; vessel segments tailed, short (150 to 250 microns), 40 to 60 microns in diameter, with simple perforations. Parenchyma paratracheal and metatracheal, indistinct at low magnifications. Fibers semilibriform to libriform, fine, aligned in radial rows. Rays plainly visible to the naked eye, 4- to 9-seriate, storied, with many gum cysts occluded with orange gum; ripple marks present, traceable to storied vessel segments, fibers (the expanded middle portion), and rays.

Key to the species of Aegiceras Gaertner.

1. Vessels 100 to 250 per square millimeter, the largest 40 to 50 microns in diameter; fibers nonlibriform to semilibriform; rays 2- to 4-seriate, 30 plus cells high, with 1 to 4 gum cysts (*t*); ripple marks distinct to the naked eyed.. *A. corniculatum.*
1. Vessels 80 to 120 per square millimeter, the largest 50 to 60 microns in diameter; fibers semilibriform to libriform; rays 4- to 9-seriate, 60 plus cells high, with 1 to 10 gum cysts (*t*); ripple marks not distinct to the naked eye.. *A. floridum.*

AEGICERAS CORNICULATUM (Linn.) Blanco. Plate 20.[24]

Common name.—Saging-ságing.

Local names.—Timbanbákis, pilápil, pagatpát, pipsík (Bataan); saging-ságing (Capiz, Negros, Lanao, Surigao, and Mindoro); kindug-kindúg, sulásig, tinduk-tindúkan (Tayabas); dumanai (Cagayan); tindok-tindók (Leyte and Tayabas); tin-

[24] *Literature.*—Brown, 1:72; Foxworthy, Malayan Sci. Bull. 131; Philip. Journ. Sci. 538; Foxworthy and Matthews, 9; Gamble, 442; Koorders and Valeton, 5:276–278; Janssonius, 7:347; Troup, 2:637; Ridley, 2:256; The Timbers of the Malayan Penin. 1:212; Hooker, 3:533; Heyne, 2 (1927) 1219; Merrill, 3:255.

dók (Mindoro); tunduk-tundúkan (Polillo); batag-batág (Zambales); bulali (Negros); tayokón (Surigao).

General description of the wood.—Sapwood yellowish with numerous orange dots (gum cysts in the rays); heartwood dark brown, rather oily; wood dull, very smooth to the feel, odorless, moderately heavy (specific gravity about 0.6), straight grained, very fine textured. Growth rings present, inconspicuous. Pores very numerous, minute (not visible without a hand lens), crowded; vessel lines inconspicuous. Parenchyma indistinct. Rays of two kinds; large rays plainly visible to the naked eye, with numerous gum pockets occluded with orange gum; small rays indistinct without a 10x hand lens; ray fleck medium high, very conspicuous owing to the orange infiltration in the gum pockets. Ripple marks present, distinct to the naked eye on both the radial and tangential sections, about 50 per centimeter.

MINUTE ANATOMY

Growth rings demarked by a narrow zone, composed of several rows of radially flattened fibers, with few or no vessels.

Vessels very numerous, crowded, solitary or in radial rows of 2 to 9, 100 to 250 per square millimeter; orifices angular, the largest 40 to 50 microns in diameter; vessel segments storied with the larger rays and the median portion of the fibers, short (150 to 250 microns long), with short, blunt tails or truncate; lateral walls 2 to 3 microns thick; perforations simple, circular, horizontal or slightly oblique; intervessel pits numerous, minute (2 to 3 microns in diameter), crowded, round or elliptical, with broad orifices; pits leading to the rays numerous, in 4 or 5 horizontal rows in each cell, simple, round or oblong; infiltration not observed; tyloses sparse.

Parenchyma paratracheal and metatracheal, in cambiform rows of 2 to 4 (mostly 2) units along the grain; (*a*) paratracheal parenchyma abundant, 1 to 6 cells flanking the vessels or vessel groups but never forming a complete sheath; cells 16 to 24 microns wide, 100 to 120 microns long; (*b*) metatracheal parenchyma sparse; cells similar to those of the paratracheal parenchyma; orange infiltration abundant in both types of parenchyma, occluding many cells; crystals not observed; starch deposits abundant.

Fibers nonlibriform to semilibriform, fine, aligned in radial rows, short (250 to 600 microns), rounded, and 16 to 20 microns in diameter in the cross section, abruptly tapering and the

median portion storied with the vessel segments and large rays; walls 3 to 4 microns thick; interfiber pits fairly numerous, large (5 to 6 microns in diameter), round, bordered, with narrow, oblique orifices; infiltration sparse.

Rays 2 or 3 per millimeter, separated by 2 to 30 fibers, 2- to 4-seriate, homogeneous or heterogeneous, with 1 to 4 gum cysts (*t*), storied with the vessel segments and median portions of the fibers, 80 plus microns in width, and up to 30 plus cells and 700 plus microns in height; 2 to 4 rays are often arranged in a longitudinal row along the grain, and the rays of the series are then separated by 1 to 3 obliquely running fibers, or occasionally by vessels (*t*); ray cells round (*t*); "upright" cells 40 to 80 microns long, 16 to 20 microns wide, 24 to 36 microns high; "horizontal" cells 40 to 100 microns long, 12 to 16 microns wide, 12 to 24 microns high; pits leading to vessels numerous, in 4 or 5 horizontal rows in each cell, simple, round or oblong; orange gummy infiltration abundant in many cells; crystals not observed; starch deposits sparse.

Gum cysts lysigenous, 1 to 4 in each ray (*t*), 2 or 3 often confluent forming a pocket wider than the rest of the ray, about 80 microns in diameter horizontally, 100 microns in height, and approximately 300 microns (*x*) in length along the ray; an orange gum abundant, occluding the cysts.

Ripple marks distinct to the naked eye, traceable to storied vessel segments, fibers (expanded middle portion), and large rays.

Material.—Block 5526 T. S., Tayabas.

AEGICERAS FLORIDUM R. and S. Plate 21.[36]

Common name.—Tinduktindúkan.

General description of the wood.—Sapwood not present in the material examined, the samples consisting entirely of heartwood; wood dark grayish brown, odorless, dull, smooth to the feel, hard, moderately heavy (specific gravity about 0.7), shallowly interlocked grained, very fine textured, and taking a very smooth finish. Growth rings distinct. Pores very numerous, evenly distributed, minute, arranged in radial rows or in small nests; vessel lines inconspicuous. Parenchyma indistinct. Rays plainly visible to the naked eye, with numerous gum cysts, occluded with orange gum; ray fleck high, conspicuous, light yellowish brown or orange-brown, owing to the numerous orange

[36] *Literature.*—Brown, 1:76; Foxworthy, Philip. Journ. Sci. 538; Foxworthy and Matthews, 9; Hooker, 3:533; Merrill, 3:256.

gum cysts. Ripple marks present, indistinct without a hand lens.

MINUTE ANATOMY

Growth rings demarked by a narrow zone of several rows of somewhat radially flattened fibers devoid of vessels, followed occasionally in the preceding ring by a porous belt of crowded vessels.

Vessels very numerous, somewhat crowded at the beginning of the ring, solitary, in short radial groups of 2 to 8, or in small nests, 80 to 120 per square millimeter; orifices somewhat angular, the largest 50 to 60 microns in diameter; vessel segments storied with the fibers, 150 to 250 microns long, truncate or occasionally with short, blunt tails; lateral walls 3 to 4 microns thick; perforations simple, circular, horizontal or occasionally oblique; intervessel pits numerous, minute (2 to 3 microns in diameter), round, with broad orifices; pits leading to rays simple, in 4 or 5 horizontal rows in each cell, rounded, tyloses absent, infiltration not observed.

Parenchyma paratracheal and metatracheal, in cambiform rows of 2 to 4 (mostly 2) units along the grain; (*a*) paratracheal parenchyma abundant, 1 to 6 cells flanking the vessel or vessel group, but never forming a complete sheath; cells 16 to 24 microns wide, 100 to 120 microns long; (*b*) metatracheal parenchyma sparse; cells similar to those of the paratracheal parenchyma; orange infiltration abundant in both types of parenchyma, occluding many of the cells; crystals not observed; starch deposits sparse.

Fibers fine, semilibriform to libriform, aligned in radial rows, short (250 to 600 microns in length), abruptly tapering and the median portion storied with the vessel segments, round and 16 to 24 microns in diameter in the cross section; lateral walls 4 to 8 microns thick; interfiber pits, numerous, large (5 to 6 microns in diameter), round, bordered, with narrow, oblique orifices; infiltration abundant.

Rays 2 or 3 per millimeter, separated by 2 to 30 fibers, 4- to 9-seriate, homogeneous, with 1 to 10 plus gum cysts (*t*), the large often storied with vessel segments and median portion of fibers, up to 170 plus microns wide, and 60 plus cells and 1,200 plus microns in height; 2 to 4 rays are often arranged in longitudinal rows along the grain, and the rays of the series are then separated by 1 to 4 oblique fibers (*t*); ray cells rounded, 40 to 100 microns long, 12 to 20 microns wide, and 8 to 20 microns high; pits leading to rays simple, in 4 or 5 horizontal

rows in each cell, rounded; orange gummy infiltration abundant, occluding many of the cells; crystals present; starch deposits sparse.

Gum cysts lysigenous, 1 to 10 plus in each ray (t), several often confluent, forming a pocket which is about 50 microns in horizontal diameter (t) and 20 to 50 microns in height, and from 50 to 120 microns in length along the ray (x); orange gum abundant, occluding the cysts.

Ripple marks not visible to the naked eye, traceable to storied vessel segments, fibers (expanded middle portion), and large rays.

Material.—Block 3346 T. S., Mindanao.

VERBENACEÆ

The teak family consists of about 70 genera and 750 species of herbs, shrubs, and trees, confined chiefly to the Tropics and Subtropics; there are a few in temperate regions. From the standpoint of timber production teak is the best-known and most-important wood of this family. This is produced by *Tectona grandis* Linn. f., a tree indigenous to India and the Malay Archipelago and grown extensively in plantations.

In the Philippines molave, from *Vitex* spp., is the only wood of any value produced by this family; the teak tree has been planted locally but is of little importance on account of its scarcity.

Genus AVICENNIA Linnæus

Common in tidal swamps in the subtropical and tropical regions of both hemispheres. Three species have been described, two of which occur in the Philippines; of these *A. officinalis* Linn. is too scarce to be of significance. The description of the other species follows.

AVICENNIA MARINA (Forsk.) Vierh. Plate 22.[30]

Common name.—Api-ápi.

Local names.—Miápi (Samar, Leyte, and Masbate); api-ápi (Capiz, Bataan, Davao, Zamboanga, Cotabato, Palawan, and

[30] *Literature.*—Merrill, 3:407; Brown, 1:82 (*A. alba*); Schneider, 206 (*A. alba*); Foxworthy, Philip. Journ. Sci. 553 (*A. officinalis*); Whitford, 2:98 (*A. officinalis*); Heyne, 2 (1927) (*A. alba*); Baker, Australian "Grey Mangrove", Journ. Roy. Soc. N. S. Wales 19 (1915) 269 (*A. officinalis*); Baker, Hardwoods of Austr. and their Econ. 327 (*A. officinalis*); Gamble, 546 (*A. officinalis*); Kanehira, (1921) 165 (*A. officinalis*); (1924) 44 (*A. officinalis*); Janssonius, 8:829–842 (*A. alba*); Ridley, Timbers of Malayan Pen. 1 (1902) 219 (*A. officinalis*); Lecomte, 201–202 (*A. officinalis*).

Mindoro); kalapíni mañgitít (Zambales); buñgálon (Marinduque, Tayabas, Pangasinan, Zambales, Mindoro, Capiz, Iloilo, Camarines, and Negros); kulási (Cotabato); kalapíni (Pangasinan, Bataan, and Zambales); pipisíg or pipisík (Tayabas, Camarines, and Mindoro); piápi (Iloilo, Capiz, Agusan, and Tayabas); liñgóg (Cagayan); piksík (Mindoro).

General description of the wood.—Sapwood and heartwood distinct in very old trees, otherwise not separable; sapwood bluish gray; heartwood gray to olive-brown; wood dull to somewhat lustrous, rough to the feel, odorless, hard, moderately heavy (specific gravity 0.65 to 0.70), straight grained, and the grain very characteristic on the radial surface, owing to the bands of interxylary phloëm, uneven textured (coarse textured in the interxylary phloëm bands and the xylem fine textured). Growth layers abnormal, discontinuous, demarked by light, more or less undulate lines which occasionally branch, preceded by a row of large porelike openings (disorganized soft phloëm), which are plainly visible to the naked eye. Pores confined to the xylem tracts, sparse, evenly distributed, solitary or in short radial groups, barely visible to the naked eye; vessel lines fairly conspicuous owing to their orange infiltration. Porelike openings (phloëm cavities) in a single row bounded without by a tangential band consisting of stone cells and parenchyma, plainly visible to the naked eye, and forming conspicuous vessel-like lines on the radial section. Concentric bands of parenchyma and stone cells numerous, white, frequently forking. Rays numerous, fine, invisible without a 10x hand lens, seemingly interrupted at the layers of interxylary phloëm; ray fleck low, about the same color as the background and hence inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Growth layers distinct, demarked by a tangential band of interxylary phloëm.

Interxylary phloëm in concentric bands; bands more or less undulate, frequently forked, many seriate, composed of thin-walled parenchyma, with numerous scattered stone cells and uniseriate row of large porelike phloëm cavities; this followed by a layer consisting of 2 to 6 rows of stone cells and farther to the outside by 2 to 6 rows of parenchyma. Phloëm cavities (x) with tangential diameter of 170 to 250 microns, about 250 microns in radial diameter, often with remnants of disorganized phloëm tissue in which stone cells are included; parenchyma

cells of the uncrushed phloëm, thin walled rectangular in cross section, 16 to 48 microns in diameter, 20 to 60 microns long (*r*, *t*); gummy infiltration not observed in the parenchyma; crystals abundant; starch deposits sparse; stone cells boxlike, 24 to 40 microns in diameter, 32 to 50 microns long (*r*, *t*); lateral walls 10 to 20 microns thick, lumina very small, 4 to 6 microns in diameter.

Vessels restricted to the xylem tracts, solitary or in short radial rows of 2 to 5, with a 1- to 3-seriate sheath of parenchyma, which is frequently interrupted by rays contiguous to the vessel, 10 to 15 per square millimeter; orifices round or oval, the largest 90 to 100 microns in diameter; vessel segments occasionally plugged with orange gum, short (170 to 350 microns long), with short, blunt tails; lateral walls 3 to 5 microns thick; perforations simple, round, horizontal or oblique; intervessel pits very numerous, round or oblong, 3 to 4 microns in diameter, with broad, round orifices; pits leading to rays numerous to each cell, similar to the intervessel pits; dark orange-brown infiltration frequent; tyloses not observed.

Parenchyma paratracheal and paratracheal-zonate, in cambiform rows of 4 to 6 units along the grain; (*a*) paratracheal parenchyma abundant, forming a 1- to 3-seriate sheath; cells 20 to 32 microns in diameter, 60 to 100 microns long; infiltration absent; crystals not observed; starch deposits wanting; (*b*) paratracheal-zonate parenchyma fairly abundant, in 1- or 2-seriate lines joining the vessels to proximate rays, or occasionally crossing the rays and then uniting several vessels; cells similar to those of the *a* parenchyma.

Fibers fine, semilibriform, not aligned in radial rows, round or oblong, and 20 to 24 microns in diameter in the cross section, 700 to 1,200 microns long; lateral walls 4 to 5 microns thick; interfiber pits sparse, round, simple; infiltration not observed.

Rays fine, close, 10 to 15 per millimeter, separated by 1 to 10 fibers, seemingly interrupted by the layer of stone cells inserted in the middle of the band of interxylary phloëm (*x*), 1- to 5- (mostly 1- or 2-) seriate, heterogeneous; of two kinds; large rays 120 plus microns wide, 30 plus cells and 1,200 plus microns in height; small rays 16 to 35 microns wide, 10 to 30 cells and 100 to 1,200 microns high; "upright" cells marginal or interspersed, 20 to 60 microns long, 16 to 25 microns wide, 30 to 50 microns high; "horizontal" cells 60 to 80 microns long, 16 to 25 microns wide, 12 to 30 microns high; pits leading to vessels nu-

merous to each cell, similar to the intervessel pits; gummy infiltration absent; crystals abundant, often several in the same cell; starch deposits not observed.

Material.—(1) Block 5527 T. S., Tayabas; (2) Block 5223 T. S., Tayabas; (3) Museum plank 222, Masbate; (4) Kuala Lumpur, Federated Malay States, F. W. Foxworthy.

Uses.—Firewood, also is used locally for rice mortars and oil mills; a favorite in some regions for smoking fish.

BIGNONIACEÆ

This family includes about 100 genera and 600 species of trees, climbers, and herbs, which are widely distributed in the tropical and subtropical regions of both hemispheres; there are a few in the temperate zones.

The family Bignoniaceæ is represented in the Philippines by 3 genera in which the species are shrubs or small trees of no importance in the lumber trade.

Genus DOLICHANDRONE Fenzl

This genus consists of 6 to 10 species, confined for the most part to sandy beaches and tidal rivers in tropical Africa, Asia, the Pacific Islands, and Australia. *Dolichandrone spathacea* (Linn. f.) K. Schum. occurs in the mangrove swamps of the Philippine Islands.

DOLICHANDRONE SPATHACEA (Linn. f.) K. Schum. Plate 23.[n]

Common name.—Tuwí.

Local names.—Tañgahás (Mindanao); tewí (Agusan); tiwí (Camiguin); tuwí (Zambales, Bataan, Bulacan, Rizal, Manila, Cavite, Batangas, Camarines, Mindoro).

General description of the wood.—Distinct heartwood wanting; wood creamy white to light brown, dull to somewhat lustrous, smooth to the feel, odorless, soft, light (specific gravity about 0.5), straight or shallowly interlocked grained, fine textured. Growth rings distinct. Pores more numerous and somewhat larger at the beginning of the ring, solitary or arranged in short radial groups of 2 or 3, medium large (barely visible to the naked eye), often jointed by concentric lines of parenchyma; vessel lines light yellow-brown, not very conspicuous. Parenchyma in numerous, white, concentric lines which frequently unite a number of vessels. Rays numerous, very fine,

[n] *Literature.*—Whitford, 2:99; Schneider, 210; Heyne, 2 (1927) 1370; Hooker, 4:378; Janssonius, 8:736; Merrill, 3:444.

barely visible with a 10x hand lens; ray fleck low, about the same color as the background and hence inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Growth rings very conspicuous, demarked by a narrow zone consisting of several rows of radially flattened fibers, and a 2- or 3-seriate concentric band of terminal parenchyma.

Vessels solitary, in short radial groups of 2 or 3, or in small nests, more numerous and larger at the beginning of the ring, with a 1- or 2-seriate sheath of parenchyma which is frequently interrupted by rays contiguous to the vessel, many frequently united by a band of zonate parenchyma, 9 to 12 per square millimeter; orifices round or slightly elongated radially, the largest 120 to 130 microns in diameter; lateral walls 4 to 5 microns thick; vessel segments short (250 to 500 microns long), tailed or truncate; perforations simple or reticulate, round, horizontal; intervessel pits numerous, round, about 4 microns in diameter, with narrow orifices; pits leading to the rays numerous to each cell, in 3 or 4 horizontal rows, bordered, round, with very narrow orifices; tyloses sparse; light orange-brown gummy infiltration frequent.

Parenchyma paratracheal, metatracheal-zonate, and terminal, in cambiform rows of 2 to 6 (mostly 4) units along the grain; (*a*) paratracheal parenchyma abundant, forming a 1- or 2-seriate sheath; cells thin walled, 45 to 50 microns in diameter, 50 to 100 microns long; gummy infiltration not observed; crystals absent; starch deposits occasional; (*b*) metatracheal-zonate parenchyma in numerous, 2- to 5-seriate, concentric bands which unite a number of vessels, and alternate with wider bands of fibrous tissue; cells thin walled, 25 to 35 microns in diameter, 80 to 160 microns long; infiltration as above; (*c*) terminal parenchyma in a 2- or 3-seriate band; cells similar to those of the *b* parenchyma.

Fibers nonlibriform, aligned in radial rows, in 4- to 16-seriate bands which alternate with the narrower bands of zonate parenchyma, rectangular and 20 to 30 microns in diameter in the cross section, short (400 to 1,000 microns); interfiber pits numerous, arranged in pocketlike groups on the radial walls, sparse on the tangential walls, rounded, 2 to 3 microns in diameter; infiltration not observed.

Rays fine, close, 9 or 10 per square millimeter (x), 40 to 50 per square millimeter (t), separated by 2 to 10 fibers, uniseriate or occasionally biseriate, homogeneous, indistinctly storied; the

largest 20 microns wide, and 16 plus cells and 300 plus microns in height; cells rounded (*t*), 20 to 80 microns long, 12 to 16 microns wide, 16 to 30 microns high; pits leading to the vessels numerous in each ray cell, in 3 or 4 horizontal rows, round, bordered, and with very narrow orifices; gummy infiltration sparse; crystals present; starch deposits not observed.

Material.—Block 5527 T. S., Tayabas.

Uses.—Wooden-shoe soles; handles for kitchen and other household implements.

RUBIACEÆ

The madder family consists of about 350 genera and 4,500 species of trees, shrubs, and herbs, widely distributed throughout the world, but most numerous in the Tropics. Many useful dyes, drugs, and edible products are produced by this group, among which cinchona (the source of quinine) and coffee deserve special mention. The former is obtained from the bark of trees belonging to the genus *Cinchona* Linn.; coffee beans are the seeds of *Coffea arabica* Linn., a small tree extensively cultivated throughout the Tropics. The family is represented in the Philippines by numerous genera, of which *Nauclea* Linn. and *Neonauclea* Merr. include timber trees of sufficient size to be of some importance in timber production.

Genus SCYPHIPHORA Gaertner

Scyphiphora hydrophyllacea Gaertn. is found in the Islands; it is a small tree or shrub and grows along streams in mangrove swamps.

SCYPHIPHORA HYDROPHYLLACEA Gaertn. f. Plate 24.[illegible]

Common name.—Nilad.

Local names.—Arinaya (Ilocos Norte); landíng (Culion and Tayabas); tugisak (Cotabato); balasíai (Zambales); kulási' (Tayabas); hanbulali, tabáu (Negros); sagasá (Zamboanga); nílad or nílar (Tagalog).

General description of the wood.—Distinct heartwood wanting; wood dark reddish brown to chocolate brown, dull, smooth to the feel, odorless, hard, heavy (specific gravity about 0.9), straight grained, very fine textured. Growth rings obscure. Pores very numerous, evenly distributed, very small, invisible

[illegible] *Literature.*—Brown, 1:84; Foxworthy, Philip. Journ. Sci., 562; Foxworthy and Matthews, 7; Ridley, Timbers of Malayan Penin. 210; Koorders and Valeton, 8:125–127; Gamble, 418; Ridley, 2:89; Moll and Janssonius, 6:167; Hooker, 2:125; Heyne, 2 (1927), 1399; Merrill, 3:533.

without a 10x hand lens, plugged with light brown infiltration; vessel lines inconspicuous. Parenchyma indistinct. Rays numerous, very fine, barely visible with a 10x hand lens; ray fleck low, inconspicuous. Ripple marks absent.

MINUTE ANATOMY

Vessels solitary or occasionally in radial groups of 2 or 3, 50 to 80 per square millimeter; orifices round or oval, the largest 50 to 60 microns in diameter; vessel segments plugged with yellowish gummy or granular infiltration, 700 to 800 microns long, with long-attenuate tails; lateral walls 2 to 5 microns thick; perforations simple, round, horizontal or slightly oblique; intervessel pits round, about 4 microns in diameter, with narrow orifices; pits leading to rays numerous to each cell, round; tyloses not observed; light yellow gummy and granular infiltrations abundant.

Parenchyma paratracheal, metatracheal-zonate, and metatracheal, in indistinct cambiform rows of many units along the grain; (*a*) paratracheal parenchyma sparse, restricted to 2 or 3 cells flanking the vessel; cells 16 to 20 microns in diameter, 120 to 170 microns long; small globules of light yellow infiltration frequent, crystals not observed; (*b*) metatracheal-zonate parenchyma abundant, forming numerous, broken, uniseriate lines uniting the vessels; cells similar to those of the *a* parenchyma; metatracheal parenchyma abundant; cells solitary (*x*) but otherwise similar to those of the *a* parenchyma.

Fibers fine, libriform, aligned in rather indistinct radial rows, septate or nonseptate, 80 to 1,200 microns long, 20 to 24 microns in diameter; lateral walls 6 to 8 microns thick; lumina plugged with light brown gummy infiltration; interfiber pits sparse, rounded, simple.

Rays very fine, close, 25 to 30 per millimeter, separated by 2 to 4 fibers, 1- or 2- (mostly 1-) seriate, heterogeneous and the two types of cells further characterized by differences in the color and amount of infiltration; largest rays up to 25 microns wide, and 550 plus microns and 30 plus cells high; "upright" cells marginal, usually in 2 to many rows, 20 to 40 microns wide, 80 to 200 microns high, with numerous, minute globules of dark brown gummy infiltration; "horizontal" cells in 1 to 3 rows, restricted to the body of the rays (*t*), 20 to 30 microns long, 20 to 24 microns wide, 20 to 40 microns high; occluded with light yellow gummy infiltration; crystals not observed.

Material.—Block 5529 T. S., Nilad.

Key to woods based on macroscopic characters.

1. Wood bluish gray; growth rings demarked by a row of very large, porelike cavities resulting from the disintegration of strands of interxylary phloëm .... *Avicennia marina.*
1. Wood otherwise; interxylary phloëm cavities wanting .... 2.
2. Wood creamy white to light grayish brown .... 3.
2. Wood dark gray-brown to red-brown .... 5.
3. Ripple marks present, conspicuous to the naked eye on both the tangential and radial surfaces, about 30 per centimeter; wood creamy white with black streaks .... *Camptostemon philippinense.*
3. Ripple marks absent; wood without black streaks .... 4.
4. Growth rings distinct; pores barely visible to the naked eye; wood creamy white to light brown .... *Dolichandrone spathacea.*
4. Growth rings absent; pores not visible to the naked eye; wood light grayish brown .... *Excoecaria agallocha.*
5. Ripple marks present .... 6.
5. Ripple marks absent .... 10.
6. Rays with numerous cysts occluded with orange gum; wood dark grayish brown .... 7.
6. Rays without gum cysts; wood red-brown or chocolate-brown .... 8.
7. Ripple marks not distinct to the naked eye; pores numerous. *Aegiceras floridum.*
7. Ripple marks distinct to the naked eye; pores extremely numerous. *Aegiceras corniculatum.*
8. Wood with a leatherlike odor; parenchyma in numerous, faint, closely spaced, concentric lines (x); pores distinctly visible to the naked eye .... *Heritiera littoralis.*
8. Wood without a leatherlike odor; parenchyma in distant concentric lines; pores barely visible to the naked eye .... 9.
9. Heartwood deep wine red, dull; ripple marks often indistinct without a 10x hand lens .... *Xylocarpus moluccensis.*
9. Heartwood red-brown with a golden luster; ripple marks distinct to the naked eye .... *Xylocarpus granatum.*
10. Rays indistinct to the naked eye .... 11.
10. Rays plainly visible to the naked eye .... 15.
11. Pores sparse; parenchyma in numerous, faint, concentric lines visible with a 10x hand lens .... *Cerbera manghas.*
11. Pores numerous; parenchyma indistinct .... 12.
12. Wood with a distinct roselike scent, gray-brown with a reddish tinge. *Lumnitzera racemosa.* *Lumnitzera littorea.*
12. Wood without a roselike scent, the reddish tinge wanting .... 13.
13. Wood with a swampy odor and salty taste; pores mostly in radial groups .... *Sonneratia acida.* *Sonneratia caseolaris.*
13. Wood without swampy odor or salty taste; pores mostly solitary .... 14.
14. Wood red-brown; pores round .... *Scyphiphora hydrophyllacea.*
14. Wood grayish brown to chocolate-brown; pores elliptical. *Osbornia octodonta.*

15. Wood with a leatherlike odor; parenchyma in numerous, faint, closely spaced, concentric lines; pores distinctly visible to the naked eye. *Heritiera littoralis.*
15. Wood without a leathery odor; concentric lines of parenchyma wanting; pores barely visible or invisible to the naked eye .... 16.
16. Wood with a conspicuous silvery grain on the quarter; pores barely visible to the naked eye .... 17.
16. Wood without a conspicuous silvery grain on the quarter; pores invisible to the naked eye .... 19.
17. Growth rings absent; pores round, mostly solitary. *Rhizophora mucronata.* *Rhizophora apiculata.*
17. Growth rings present; pores elliptical, mostly in radial groups of 2 to 6 .... 18.
18. Wood light brown .... *Bruguiera parviflora.*
18. Wood dark reddish brown .... *Bruguiera sexangula.* *Bruguiera conjugata.* *Bruguiera cylindrica.*
19. Rays of two sizes, the largest distinctly visible to the naked eye, the smaller invisible without a 10x hand lens .... *Ceriops roxburghiana.*
19. Rays uniform and plainly visible to the naked eye .... *Ceriops tagal.*

Key to woods based on microscopic characters.

1. Wood with concentric, branching bands of interxylary phloëm. *Avicennia marina.*
1. Wood without interxylary phloëm .... 2.
2. Vessel perforations and pits scalariform .... 3.
2. Vessel perforations and pits otherwise .... 8.
3. Largest vessels 90 to 120 microns in diameter; paratracheal-zonate parenchyma absent; fibers septate; largest rays over 5 millimeters in height .... 4.
3. Largest vessels 50 to 70 microns in diameter; paratracheal-zonate parenchyma present; fibers nonseptate; largest rays 3 millimeters or less in height .... 7.
4. Vessels mostly solitary; rays 1- to 4- (mostly 3-) seriate, the largest over 1 centimeter in height .... *Rhizophora mucronata.*
4. Vessels mostly in radial groups; rays 2- to 8-seriate, the largest less than 1 centimeter in height .... *Rhizophora apiculata.*
5. Vessels 12 to 16 per square millimeter .... *Bruguiera sexangula.*
5. Vessels 20 to 40 per square millimeter .... 6.
6. Largest rays 8 plus millimeters in height; fibers libriform. *Bruguiera parviflora.*
6. Largest rays less than 6 millimeters in height; fibers semilibriform to libriform .... *Bruguiera conjugata.* *Bruguiera cylindrica.*
7. Rays 1- to 10-seriate; vessels 50 to 70 per square millimeter, the largest 50 to 60 microns in diameter; fibers 16 to 20 microns in diameter. *Ceriops roxburghiana.*
7. Rays 1- to 5-seriate; vessels 25 to 30 per square millimeter; the largest 60 to 70 microns in diameter; fibers 24 to 28 microns in diameter. *Ceriops tagal.*

8. Perforations simple and reticulate.................... *Dolichandrone spathacea.*
8. Perforations simple throughout.. 9.
9. Rays storied .... 10.
9. Rays not storied .... 15.
10. Rays with numerous gum cysts .... 11.
10. Rays without gum cysts .... 12.
11. Rays 2- to 4-seriate, 30 plus cells high; vessels 100 to 250 per square millimeter, the largest 40 to 50 microns in diameter.
Aegiceras corniculatum.
11. Rays 4- to 9-seriate, 60 plus cells high; vessels 20 to 120 per square millimeter, the largest 50 to 60 microns in diameter.
Aegiceras floridum.
12. Rays uniseriate; largest vessels 90 to 100 microns in diameter.
Camptostemon philippinense.
12. Rays 1- to 6-seriate; largest vessels 110 to 200 microns in diameter.... 13.
13. Metatracheal-zonate parenchyma in uniseriate, concentric, close lines, separated by 1- to 4-seriate bands of fibers; largest vessels 200 microns in diameter; fibers nonseptate.................. *Heritiera littoralis.*
13. Metatracheal-zonate parenchyma in 2- to 5-seriate, concentric, distant bands; largest vessels 110 to 160 microns in diameter; fibers septate or nonseptate .... 14.
14. Rays of two sizes, the smaller 1- or 2-seriate and storied with the vessel segments, the larger 3- to 5-seriate; largest vessels 110 to 120 microns in diameter; fibers septate or nonseptate.
Xylocarpus moluccensis.
14. Rays of nearly uniform size 3- to 5- (mostly 3-) seriate; largest vessels 120 to 160 microns in diameter; fibers always septate.
Xylocarpus granatum.
15. Rays 1- to 9-seriate.. 16.
15. Rays 1- or 2-seriate.. 18.
16. Rays with gum cysts; parenchyma paratracheal and metatracheal; vessels 80 to 250 per square millimeter.................................. 17.
16. Rays without gum cysts; parenchyma paratracheal and metatracheal-zonate; vessels 6 to 10 per square millimeter....... *Heritiera littoralis.*
17. Rays 2- to 4-seriate, 30 plus cells high; vessels 200 to 250 per square millimeter, the largest 40 to 50 microns in diameter.
Aegiceras corniculatum.
17. Rays 4- to 9-seriate, 60 plus cells high; vessels 80 to 120 per square millimeter, the largest 50 to 60 microns in diameter.
Aegiceras floridum.
18. Parenchyma wanting; largest vessels 110 to 140 microns in diameter; fibers septate .... 19.
18. Parenchyma present; largest vessels 50 to 100 microns in diameter; fibers septate or nonseptate .... 20.
19. Rays uniseriate; fibers nonlibriform to semilibriform.
Sonneratia caseolaris.
19. Rays 1- to 2-seriate; fibers nonlibriform............... *Sonneratia acida.*
20. Vessels 7 to 16 per square millimeter; fibers nonlibriform............ 21.
20. Vessels 30 to 90 per square millimeter; fibers semilibriform to libriform.

21. Growth rings distinct, delineated by several rows of radially flattened fibers .... *Dolichandrone spathacea.*
21. Growth rings indistinct .... 22.
22. Fibers 20 to 28 microns in diameter; rays 10 to 13 per millimeter (x), the largest up to 25 cells and 850 microns in height, crystals present in the ray cells .... *Excoecaria agallocha.*
22. Fibers 30 to 40 microns in diameter; rays 8 or 9 per millimeter (x), the largest up to 14 cells and 600 microns in height; crystals not present in the ray cells .... *Cerbera manghas.*
23. Vessels mostly in radially groups of 2 to 7 .... 24.
23. Vessels mostly solitary .... 25.
24. Vessels 30 to 45 per square millimeter, the largest 90 to 100 microns in diameter; parenchyma paratracheal and metatracheal; rays 40 to 60 per square millimeter (t) .... *Lumnitzera littorea.*
24. Vessels 60 to 70 per square millimeter, the largest 60 to 70 microns in diameter; parenchyma paratracheal, paratracheal-zonate, and metatracheal; rays 80 to 100 per square millimeter (t). *Lumnitzera racemosa.*
25. Rays 25 to 30 per millimeter (x); "upright" cells unusually high along the grain (higher than wide), strikingly different in color, owing to infiltration; vessel orifices round; segments occluded with gummy infiltration; fibers septate, 20 to 24 microns in diameter. *Scyphiphora hydrophyllacea.*
25. Rays 15 to 18 per millimeter (x); "upright" cells not appreciably elongated vertically (t); vessel orifices oval; segments not occluded with gummy infiltration; fibers nonseptate, 8 to 16 microns in diameter .... *Osbornia octodonta.*

DISCUSSION AND SUMMARY

The anatomical structure of a plant may be considered as resulting from the effects of two factors; namely, "adaptation to environment" and "heredity." It follows that some anatomical features may be interpreted as adaptations to climate and habitat (physiological), while others are to be regarded as inherited (ancestral); the latter often predominate and are, therefore, of greater importance systematically. For instance, among mangrove-forest species, anatomical changes, such as have resulted as a protection against desiccation, are often secondary in importance to inherited characters, at least in so far as classification is concerned. Moreover, as Solereder [20] suggests, different species of plants do not necessarily respond in the same way to the influences of identical stimuli, and in consequence climate and habitat may not impress any one definite type of anatomical structure upon all the species of plants found within a given habitat. This suggestion is more or less sub-

[20] Systematic Anatomy of Dicotyledons 1:9.

stantiated by the anatomy of mangrove-forest woods, since an extremely specialized site has failed to produce identical structural changes in different species.

In the study of mangrove-forest plants, the attention of investigators has been focused chiefly on the alterations that have resulted in the external organs, and to a lesser extent in the roots. It should be interesting, therefore, to see in what way, if any, a highly saline and hence a physiologically dry habitat has affected the structure of the woods of those trees which have been able to adapt themselves to such extremely xerophytic conditions. With this idea in mind the anatomical data obtained from a detailed study of the woods of the littoral Philippine species were examined critically in order to determine what anatomical changes could be interpreted as adaptations to habitat.

The woods of all species were found to be typical diffuse porous (growth rings either wanting or poorly outlined), very fine textured, and in most cases in addition possessed fairly numerous or extremely numerous vessels (30 to over 200 plus per square millimeter in *Aegiceras*). Those in which the vessels are not numerous (less than 15 to the square millimeter) are characterized by thin-walled fibers with wide lumina. The diameters of the vessels were found to be small or very small, with a maximum diameter rarely exceeding 150 microns (usually less than 100 microns). The last values are considerably below the average for a similar number of species growing under normal (upland) conditions. On the other hand, the length of the vessel segments, which ranges from 150 to 1,200 microns, proved not to be conspicuously different from that of closely allied species of different habitat. All the species of the subfamily Rhizophoræ are littoral and possess scalariform perforations, as contrasted with the Legnotidæ—the inland Rhizophoraceæ of mesophytic habitat—which have either scalariform or simple perforations (mostly simple). This perhaps may be taken as an indication of a retarding influence of a xerophytic habitat on the evolutionary changes in the structure of the wood elements. Even in this case, however, this influence is apparent only in closely allied species since the wood of all other "littorals" (other than the Rhizophoraceæ) covered in this paper have simple perforations; the lone exception is that of *Dolichandrone*, which possesses a rare type of reticulate perforation in addition to the simple type. The fibers are usually

thick walled and often septate, with simple or bordered pits, and with a high infiltration content. Wood parenchyma is fairly abundant (absent in *Sonneratia*), and generally reaches its best development around the vessels. Exceptions appear in *Camptostemon, Cerbera, Scyphiphora, Dolichandrone, Excoecaria,* and *Heritiera* where paratracheal-zonate parenchyma predominates. The rays range from uniseriate to multiseriate; those of the latter type are from 2- to 10-seriate, and attain a considerable height (5 millimeters to 1 centimeter) in *Rhizophora* and *Bruguiera*.

Anomalous structures of various types are frequent in the woods of the mangrove forest, among which the concentric bands of outer xylary phloëm in *Avicennia*, the scattered bundles of phloëm near the pith in *Lumnitzera* and *Sonneratia*, the gum cysts in the rays of *Aegiceras*, and the peculiar reticulate perforations of *Dolichandrone* are worthy of special note.

The results of this brief anatomical survey of the woods of the Philippine mangrove forests are in agreement with Solereder's hypothesis; namely, that habitat does not impress any definite type of anatomical structure upon different species. This is shown by the fact that no matter what structural changes have taken place in the wood of the mangroves, these changes are not identical in different species. Naturally, more-extensive research is necessary before any definite conclusions can be drawn, and future investigators would do well to conduct their researches along three lines; namely, an examination and a comparative study of the woods of littoral species from different localities; a comparative study of their anatomy, with that of closely allied species, growing under different conditions; and the evolutionary significance of such changes as appear to have resulted from the influence of a specialized environment.

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ILLUSTRATIONS

[The wood of one species is figured in cross section on each plate. The upper figure is magnified × 15; the lower, × 110.]

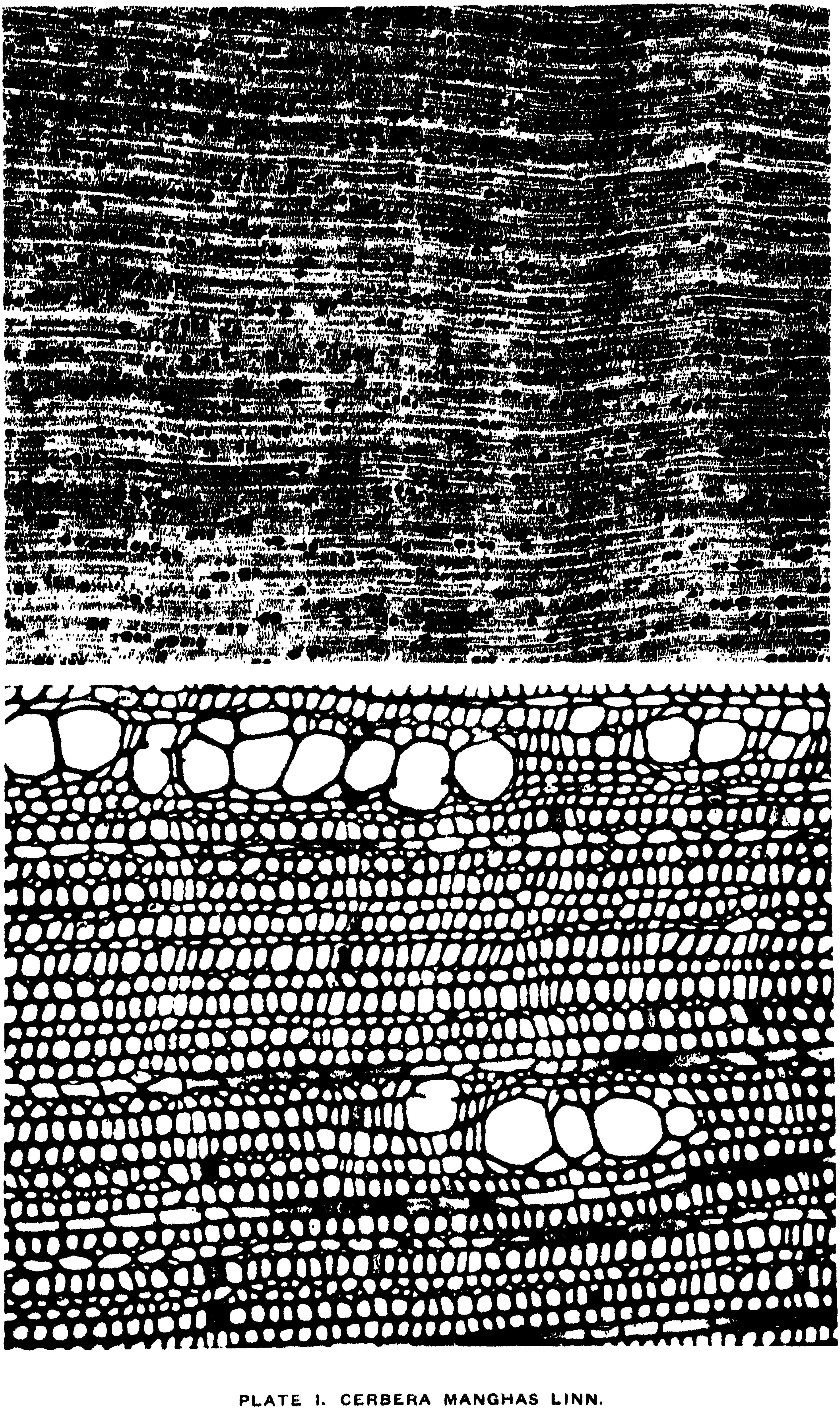


PLATE 1. CERBERA MANGHAS LINN.

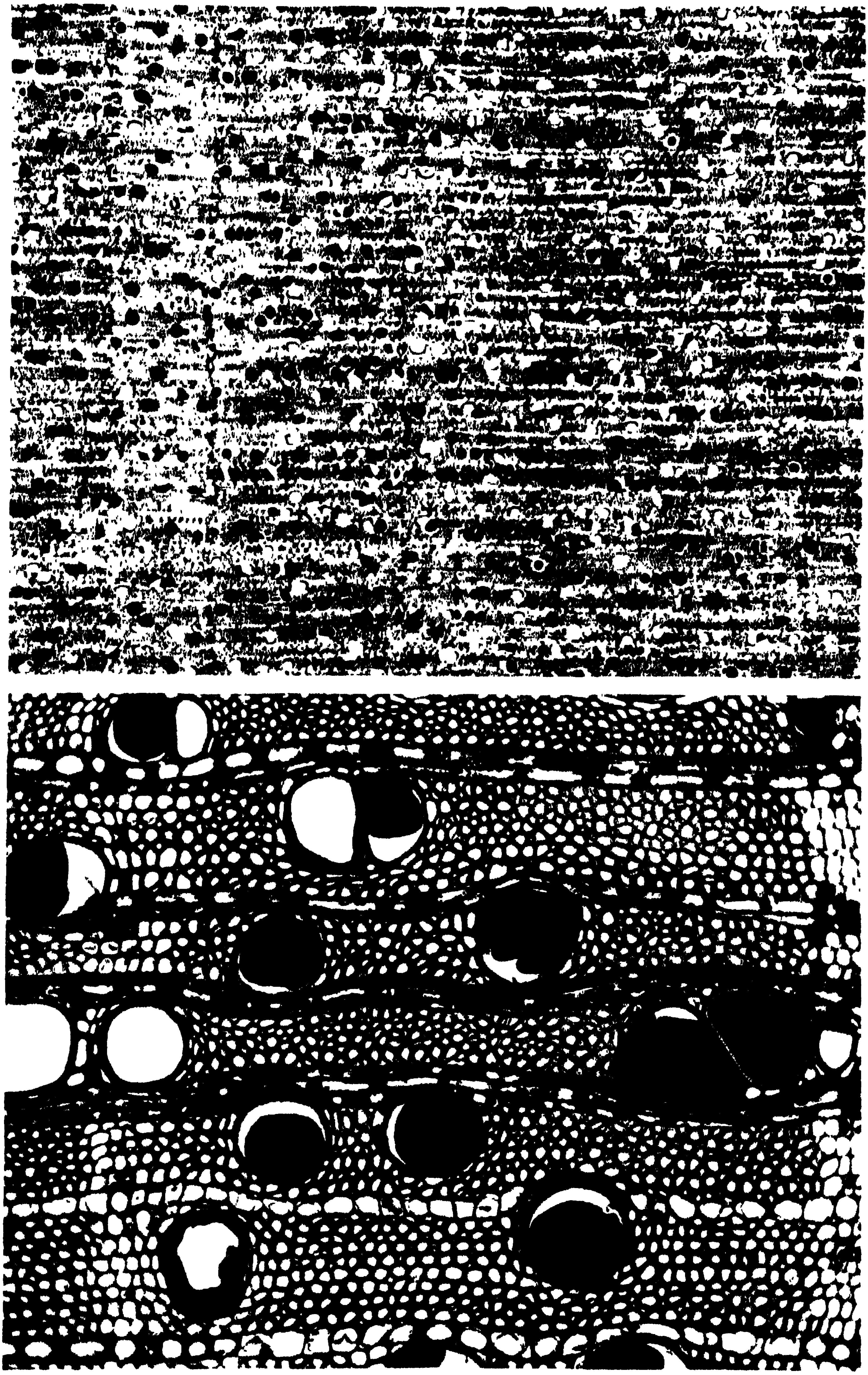


PLATE 2. XYLOCARPUS GRANATUM KOEN.

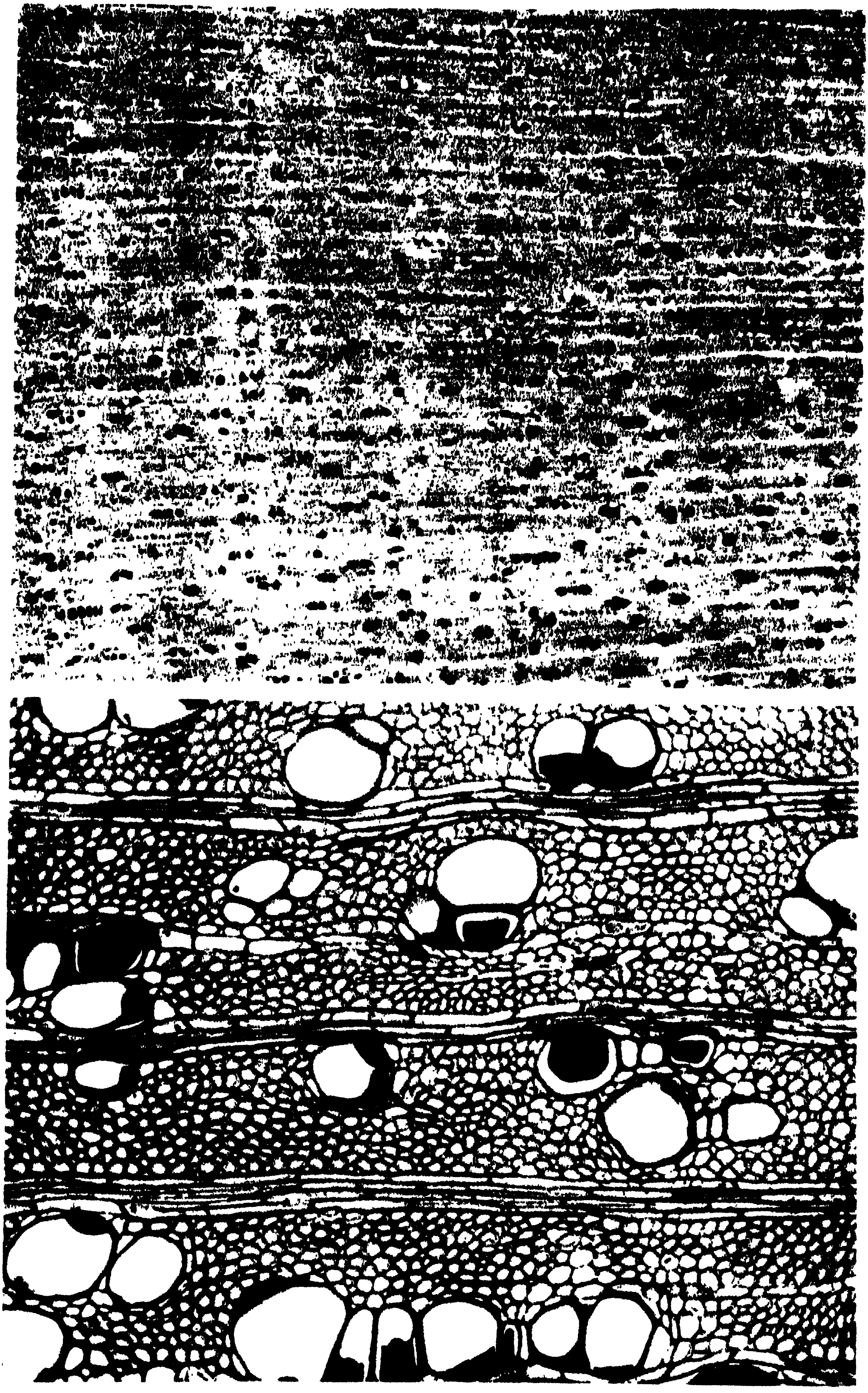


PLATE 3. XYLOCARPUS MOLUCCENSIS (LAM.) M. ROEM.

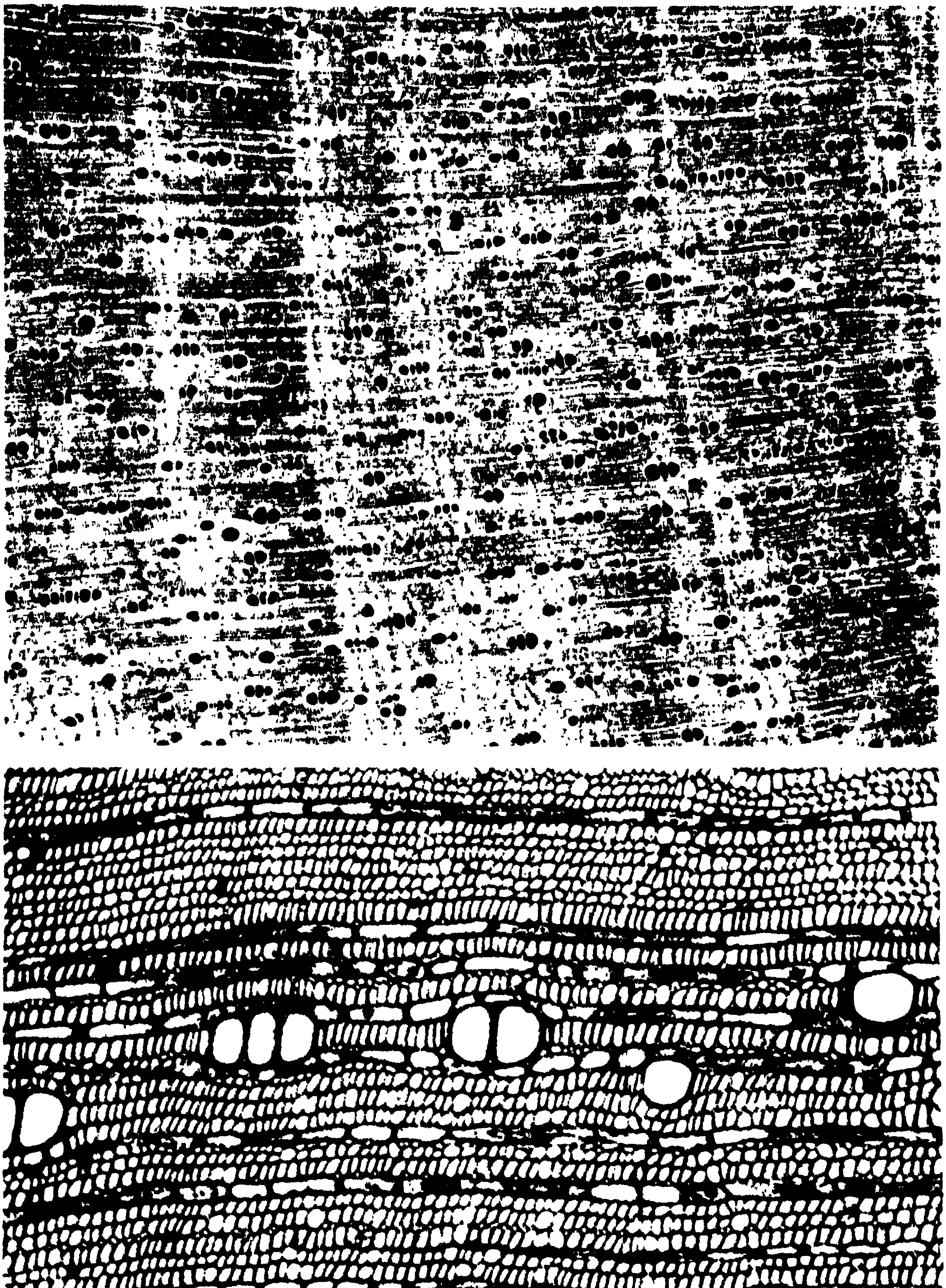


PLATE 4. EXCOECARIA AGALLOCHA LINN.

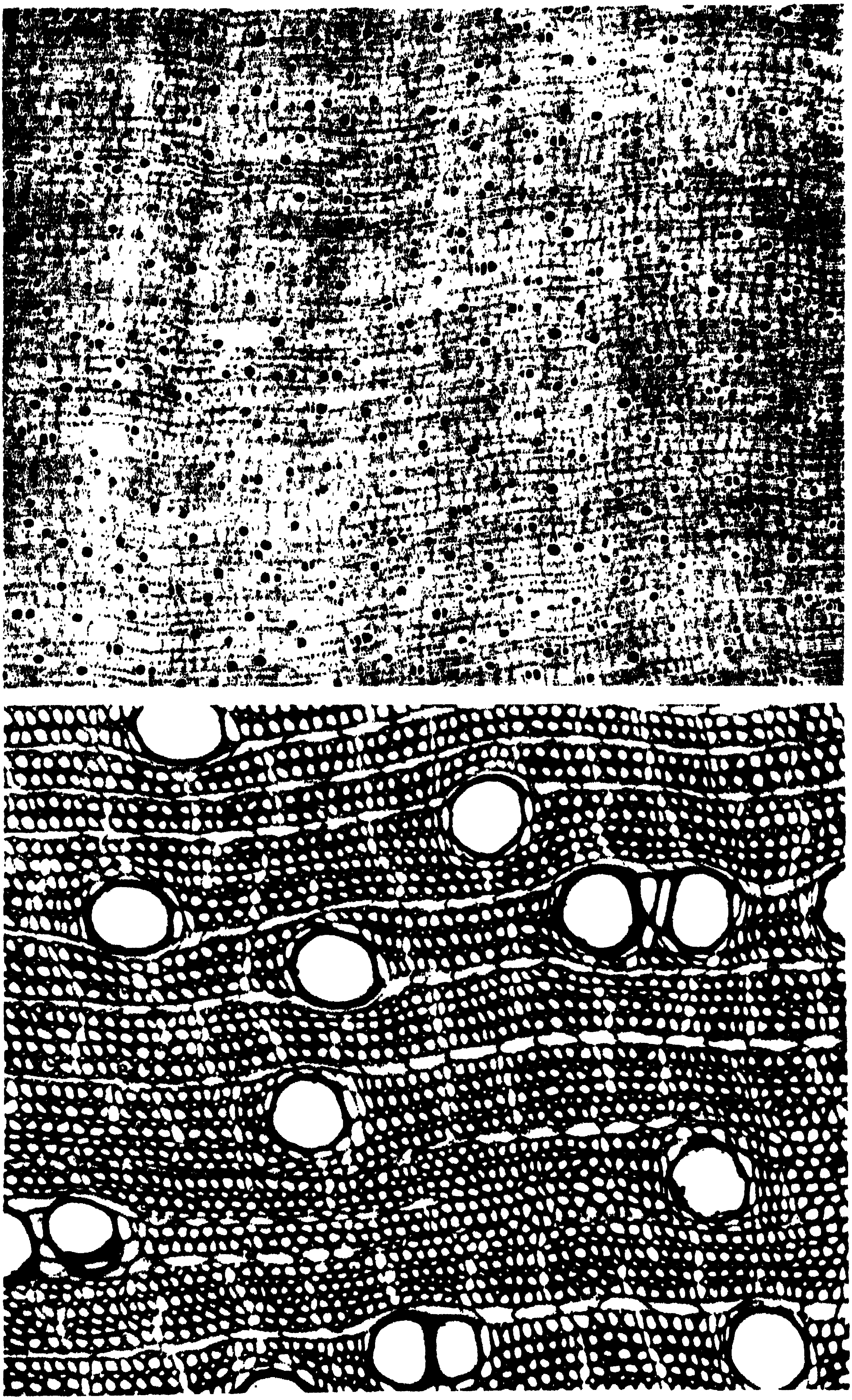


PLATE 5. CAMPTOSTEMON PHILIPPINENSE (VID.) BECC.

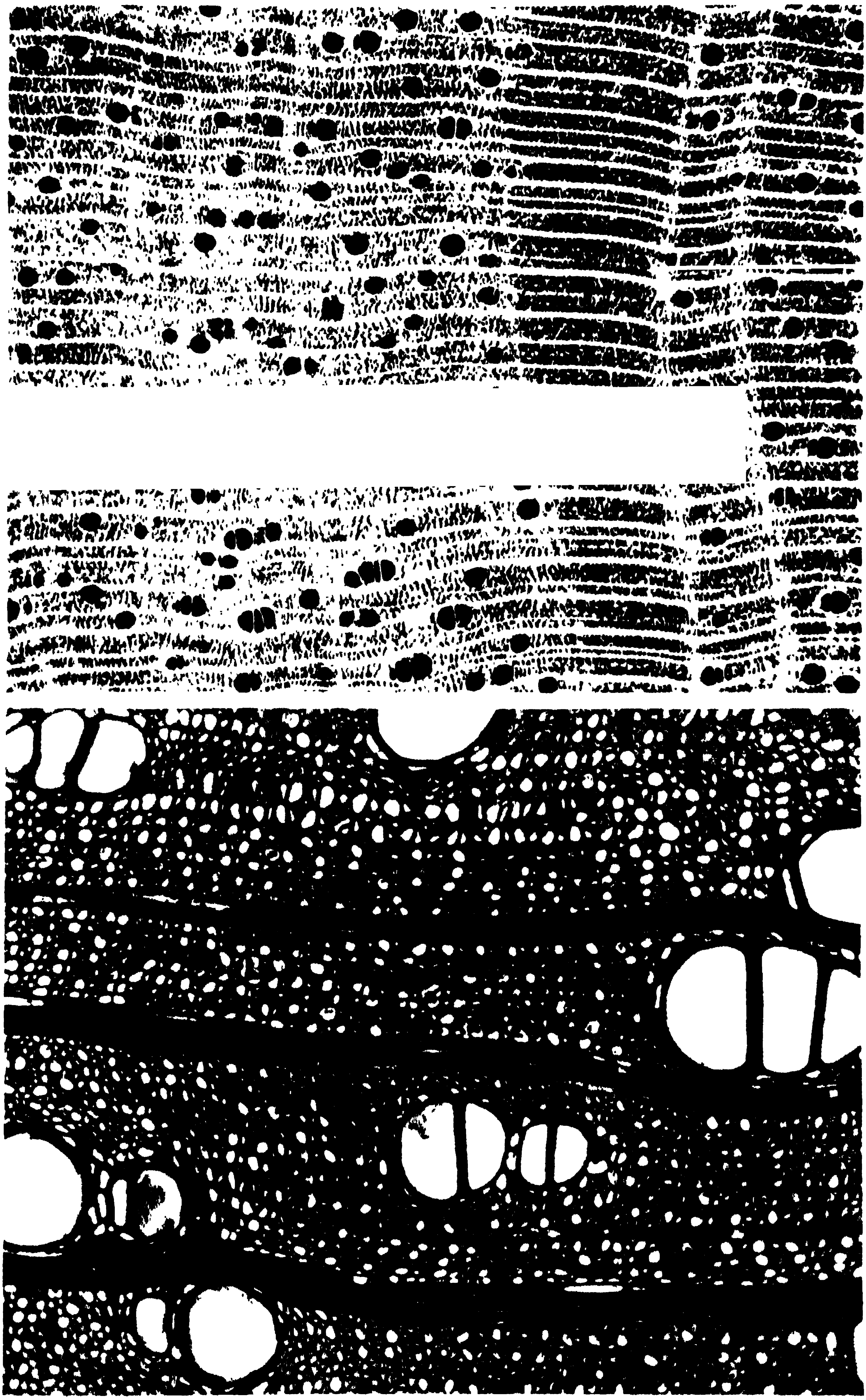


PLATE 6. HERITIERA LITTORALIS DRYAND.

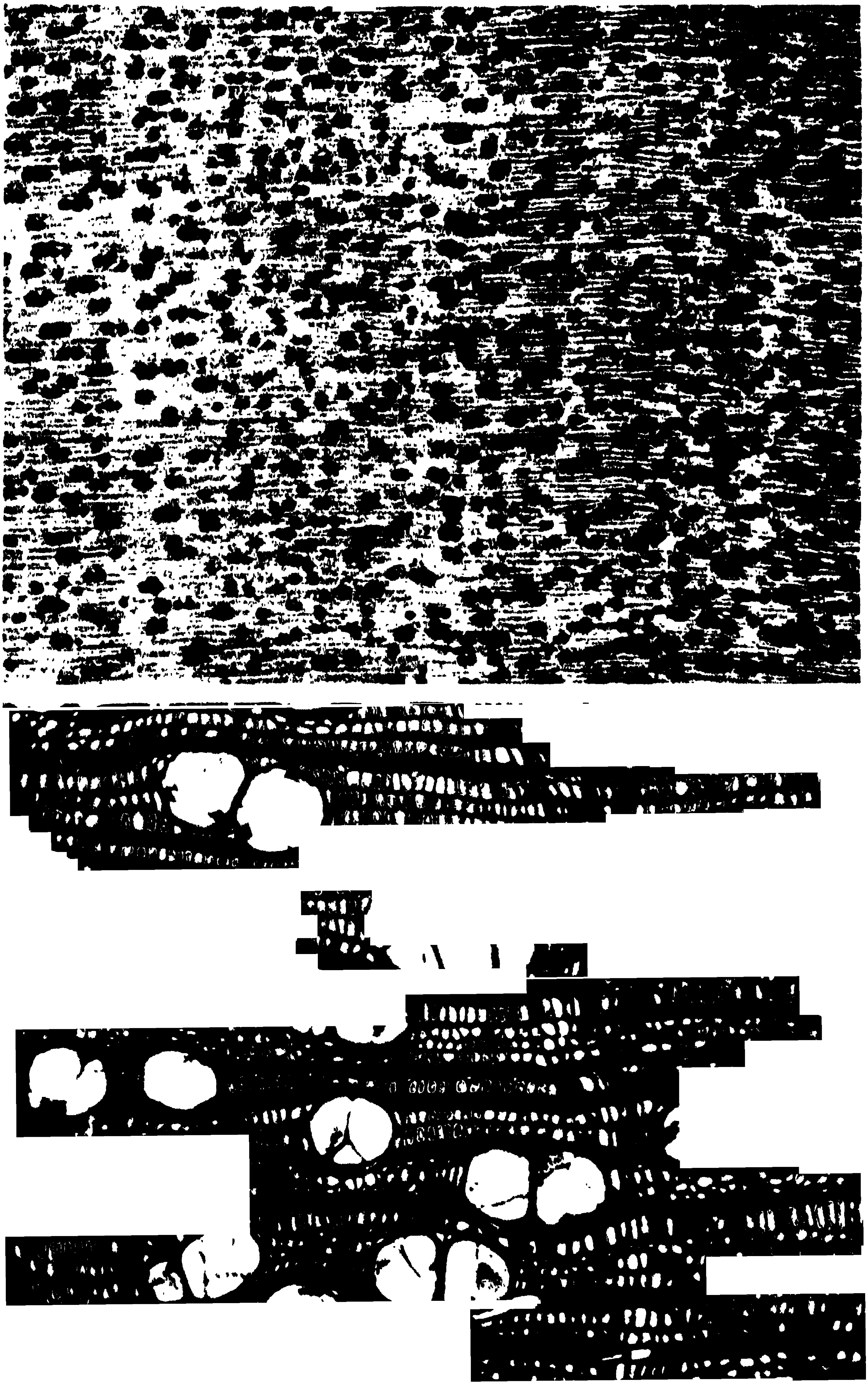
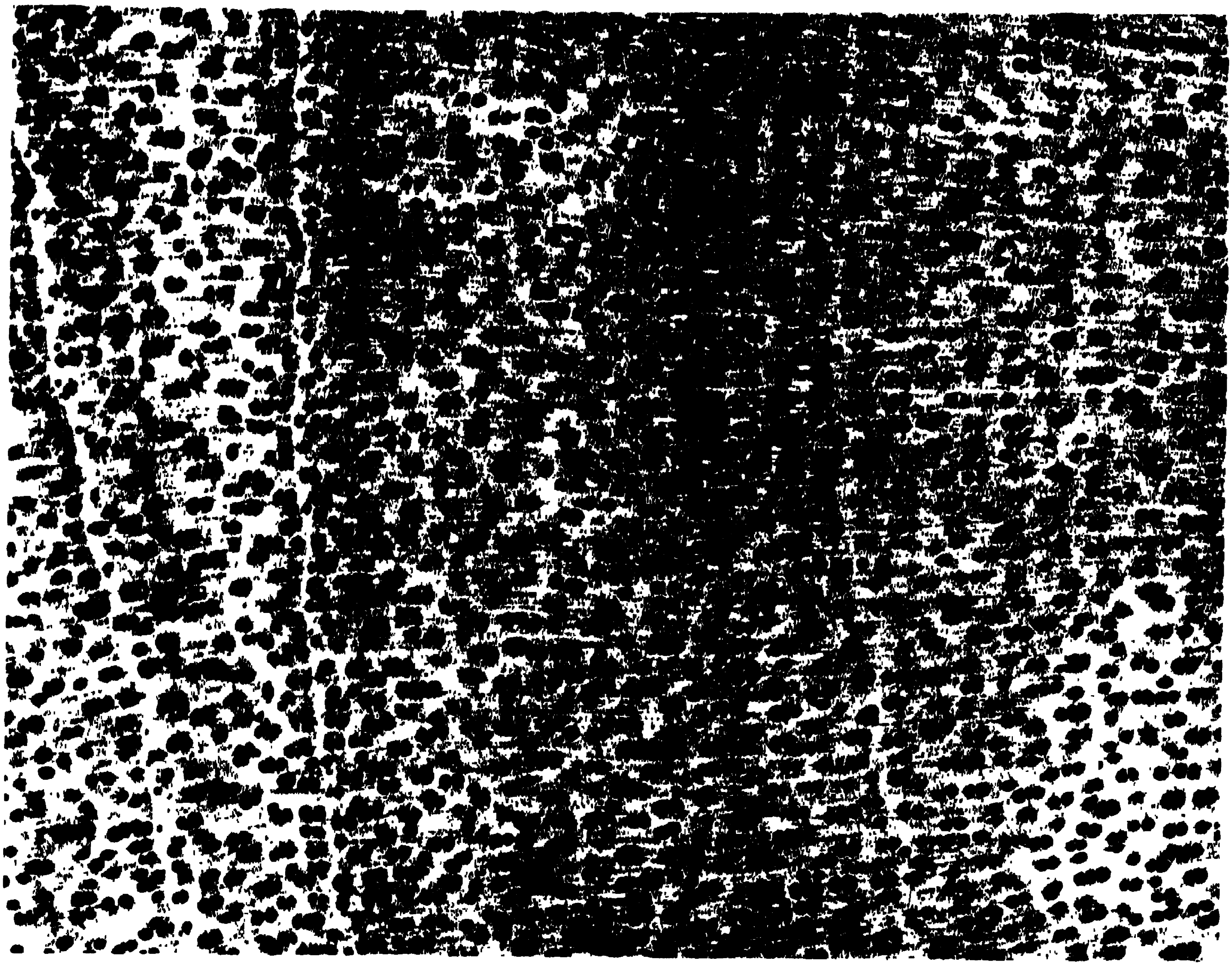


PLATE 7. SONNERATIA CASEOLARIS (LINN.) ENGL



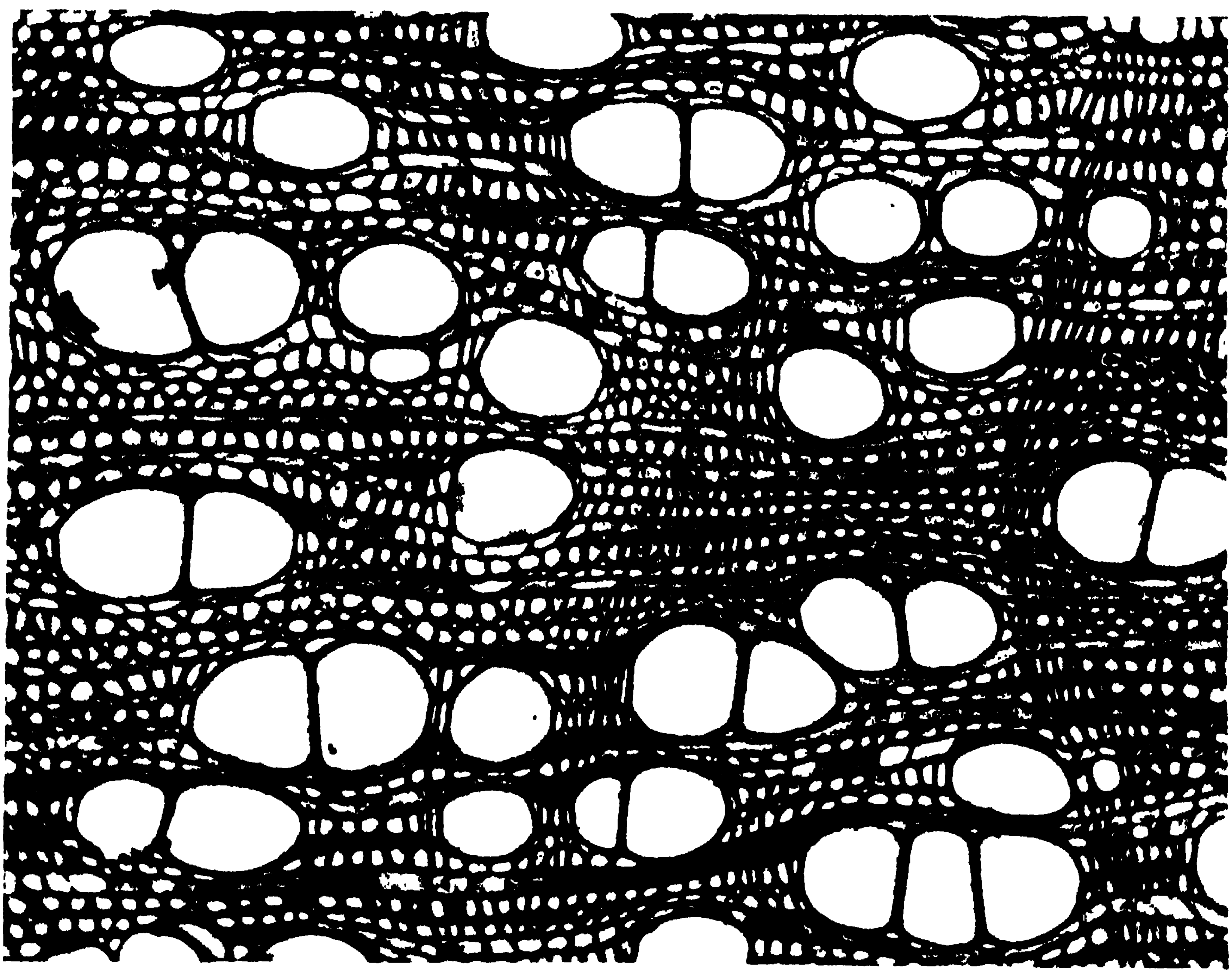
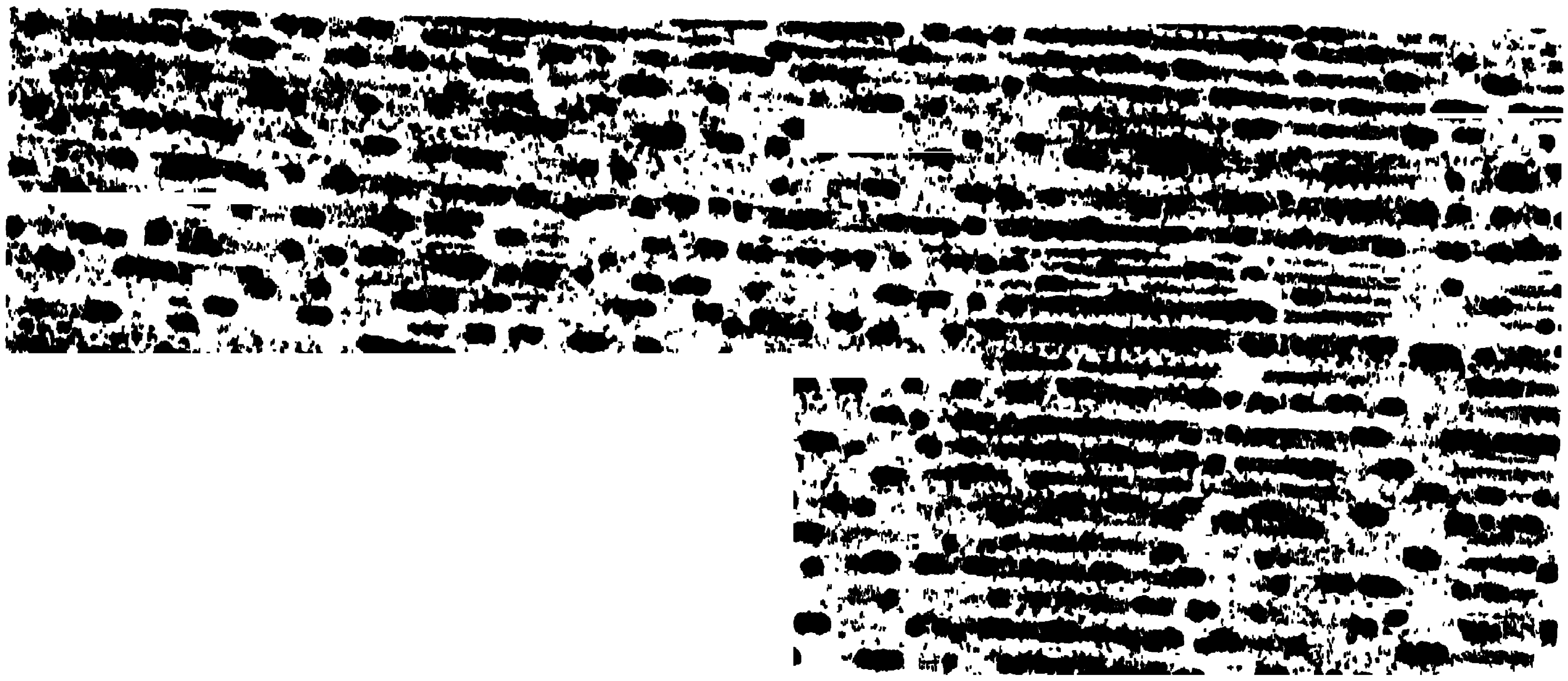
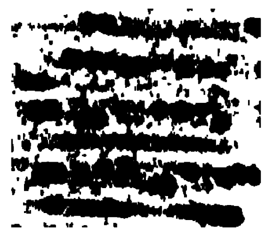
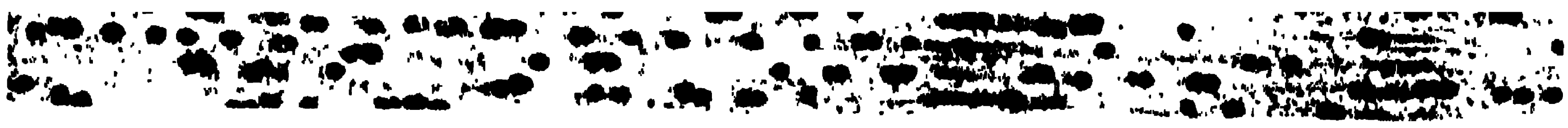


PLATE 8. SONNERATIA ACIDA LINN. F.







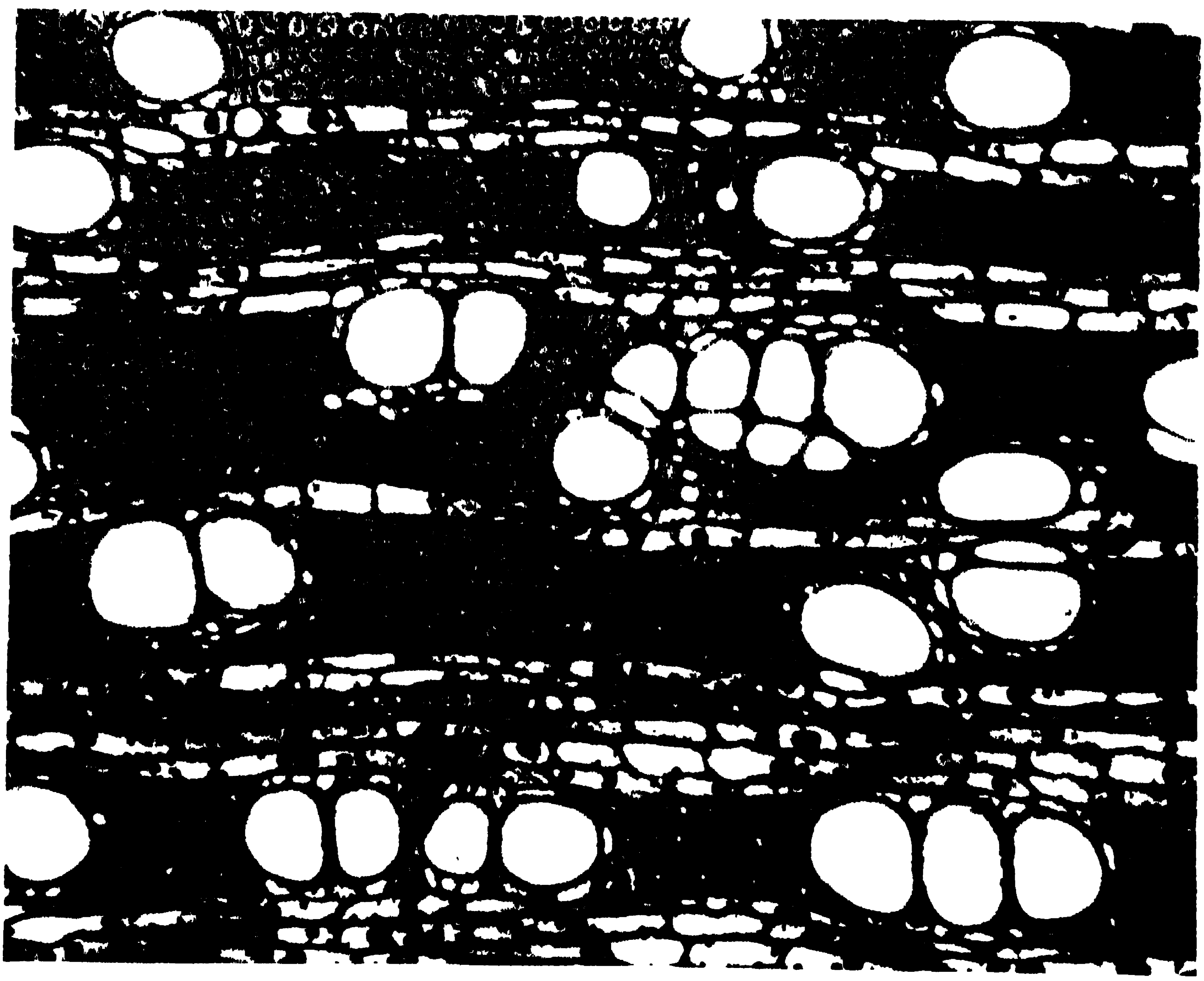


PLATE 9. BRUGUIERA CONJUGATA (LINN.) MERR.

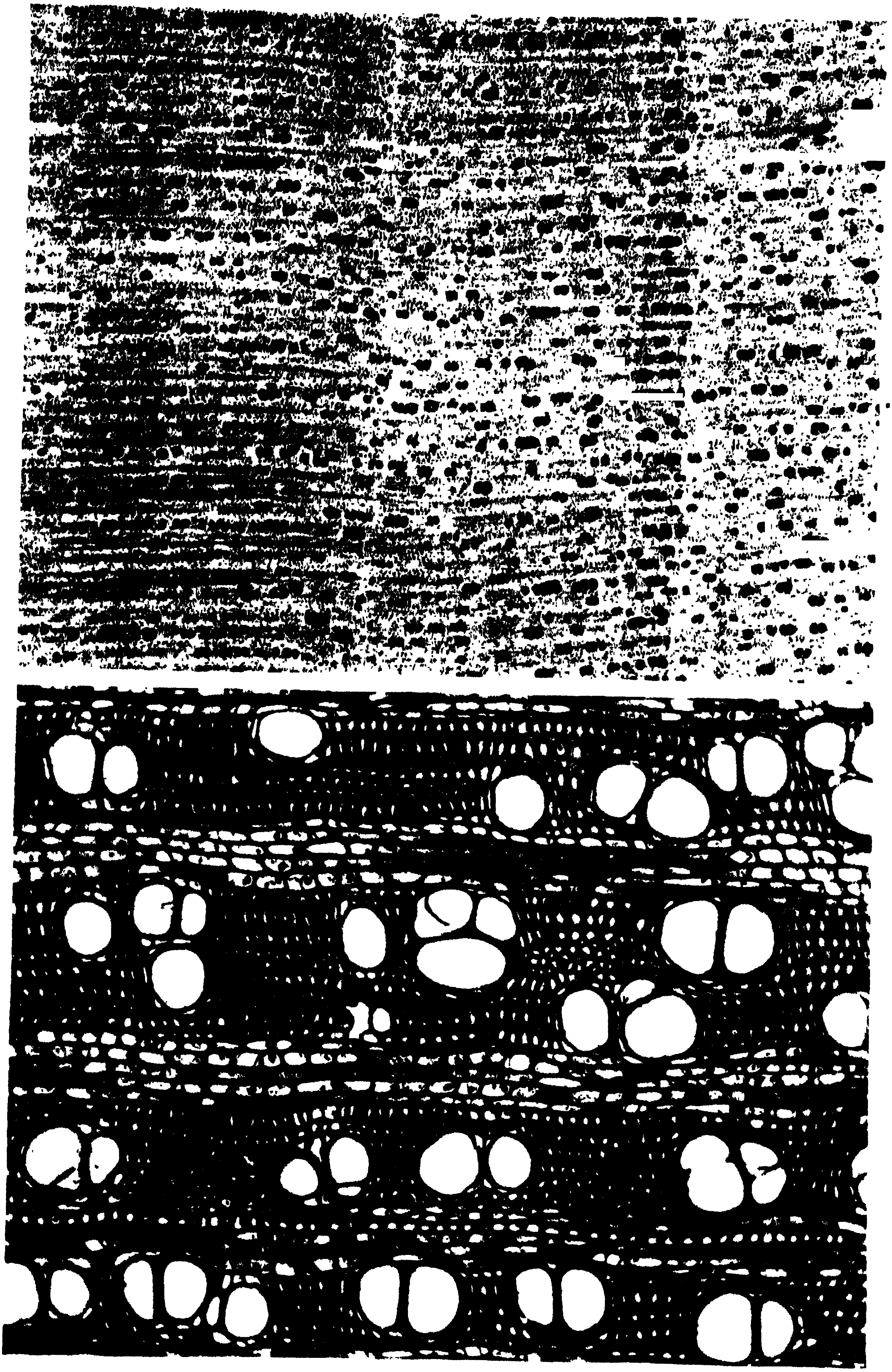
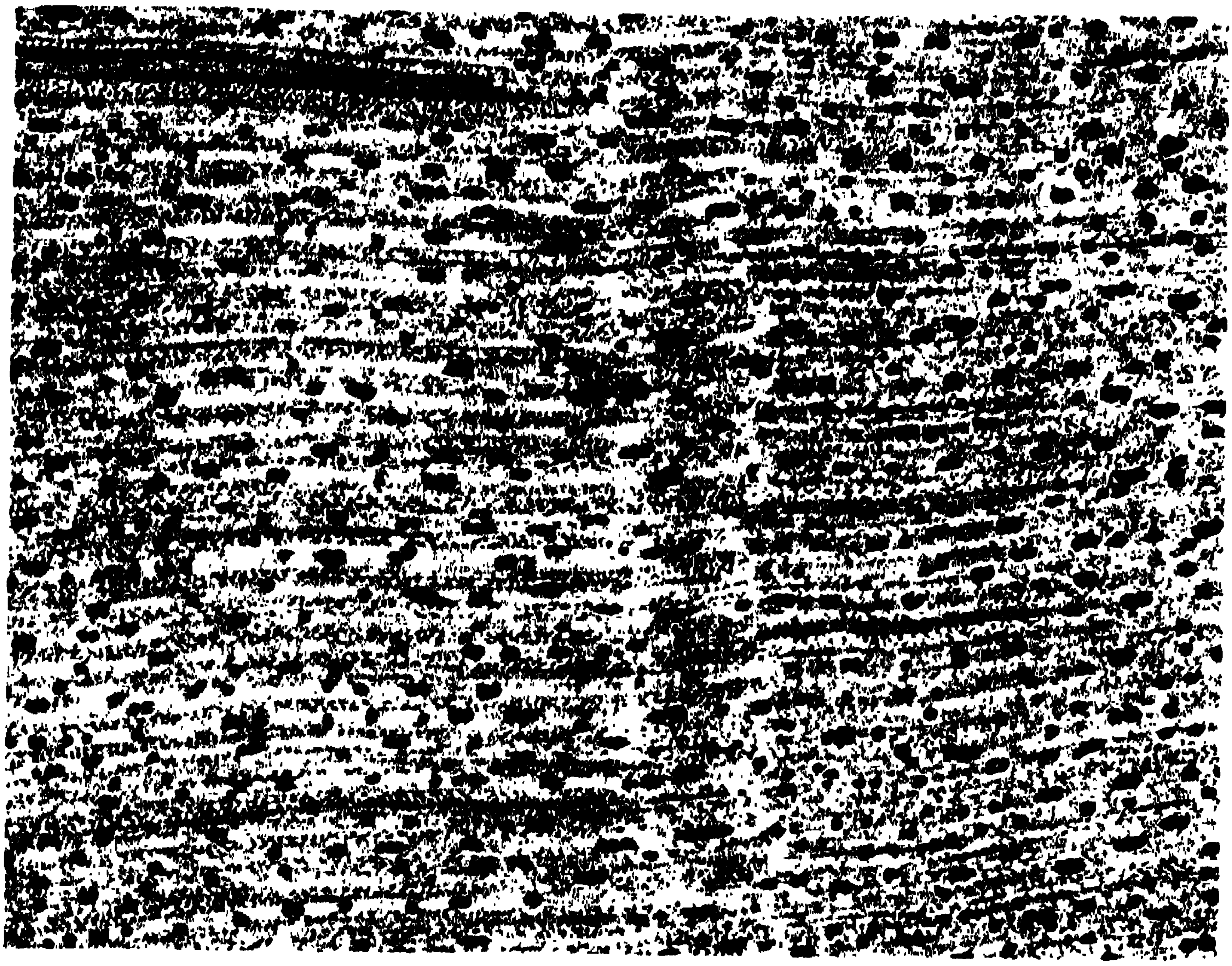


PLATE 10. BRUGUIERA CYLINDRICA (LINN.) BLUME.



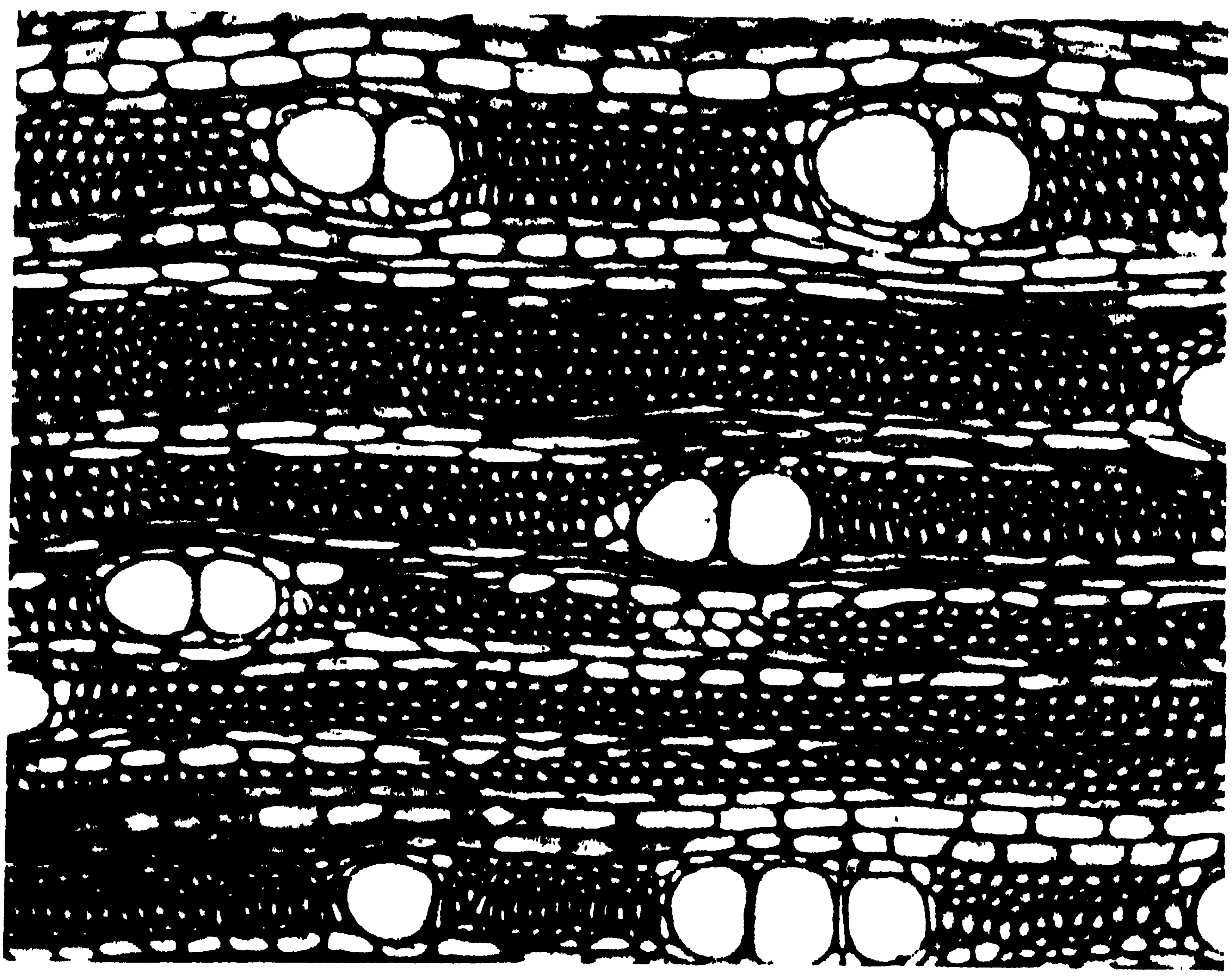
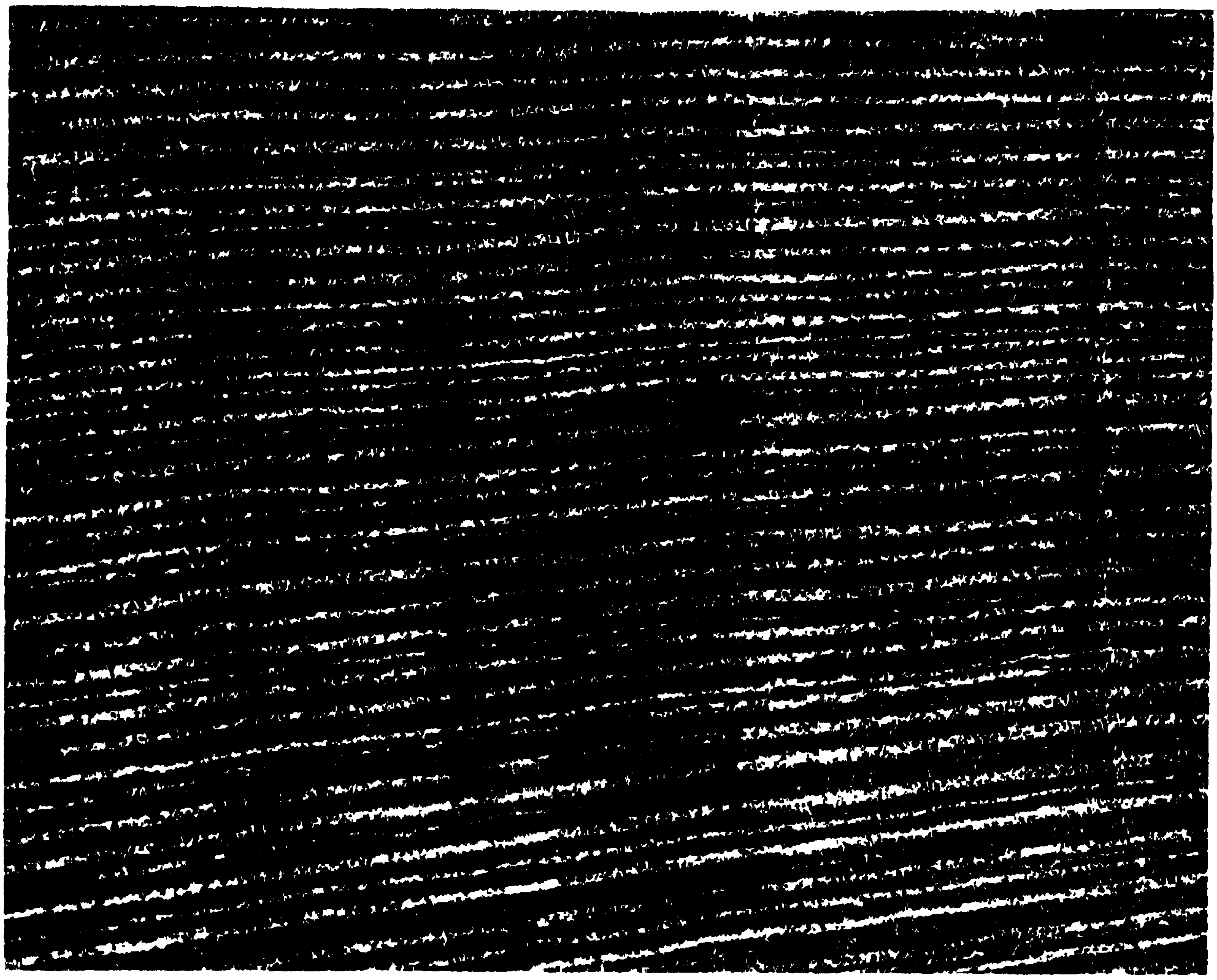


PLATE 11. BRUGUIERA SEXANGULA (LOUR.) POIR.



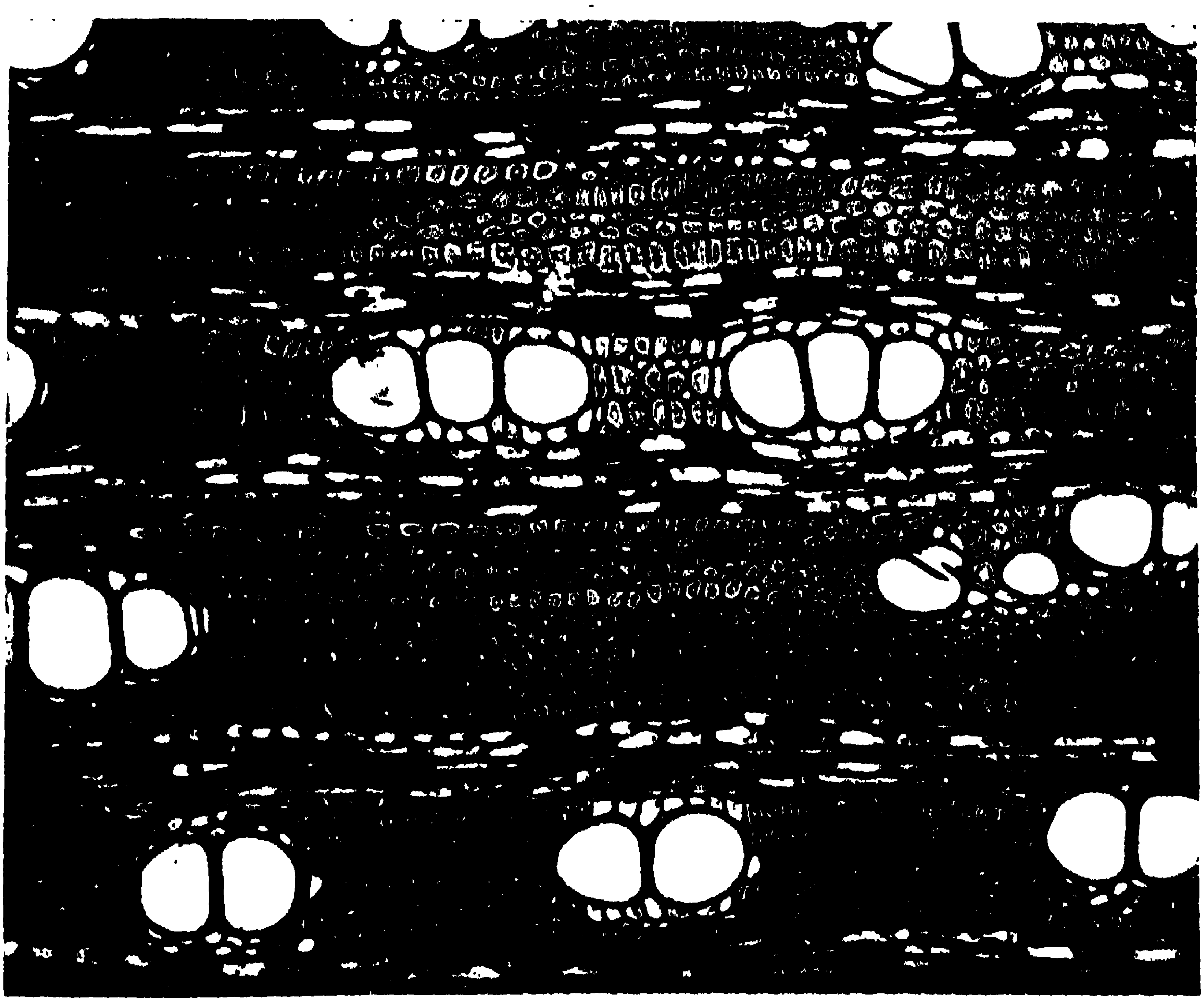
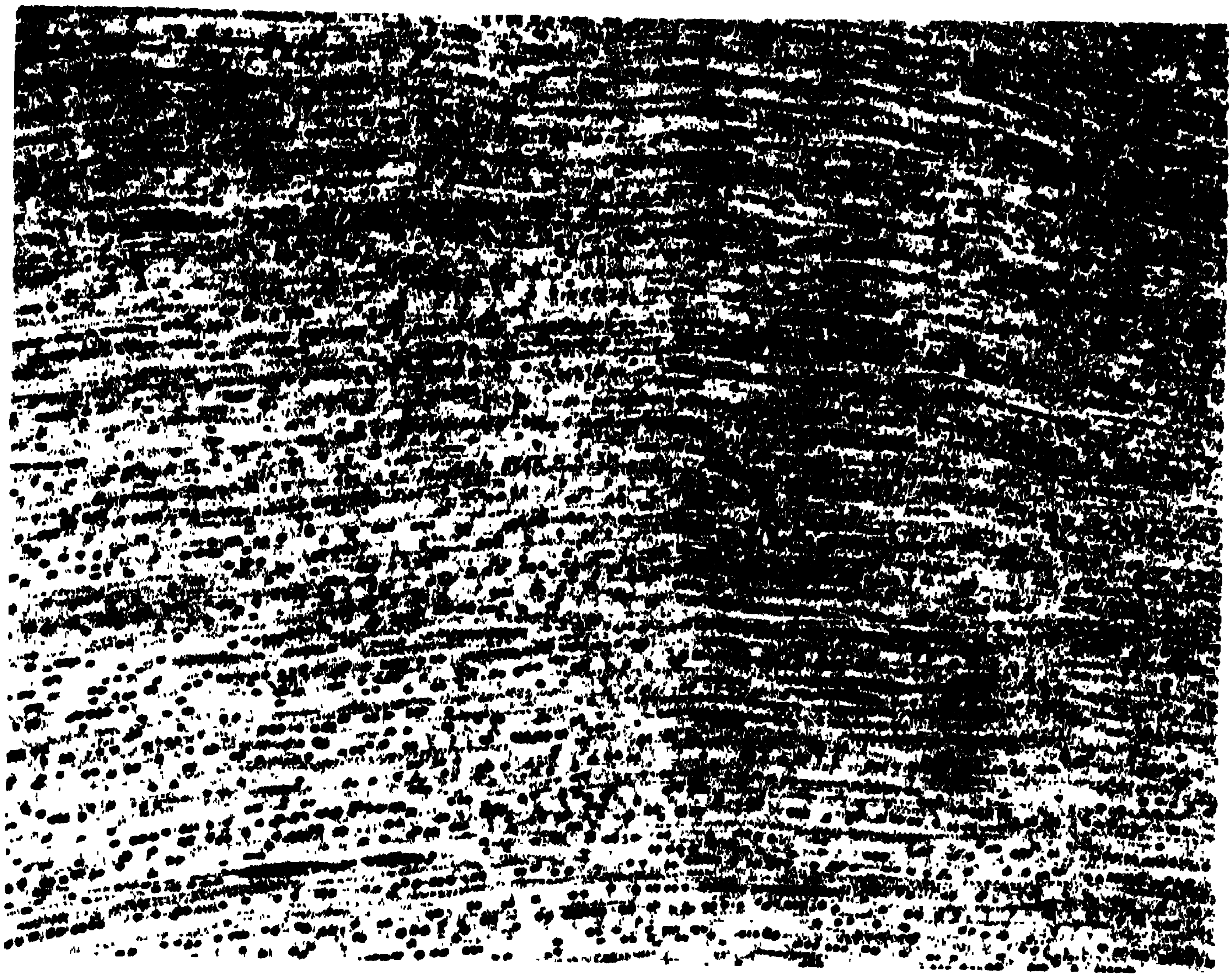


PLATE 12. BRUGUIERA PARVIFLORA (ROXB.) W. AND A.



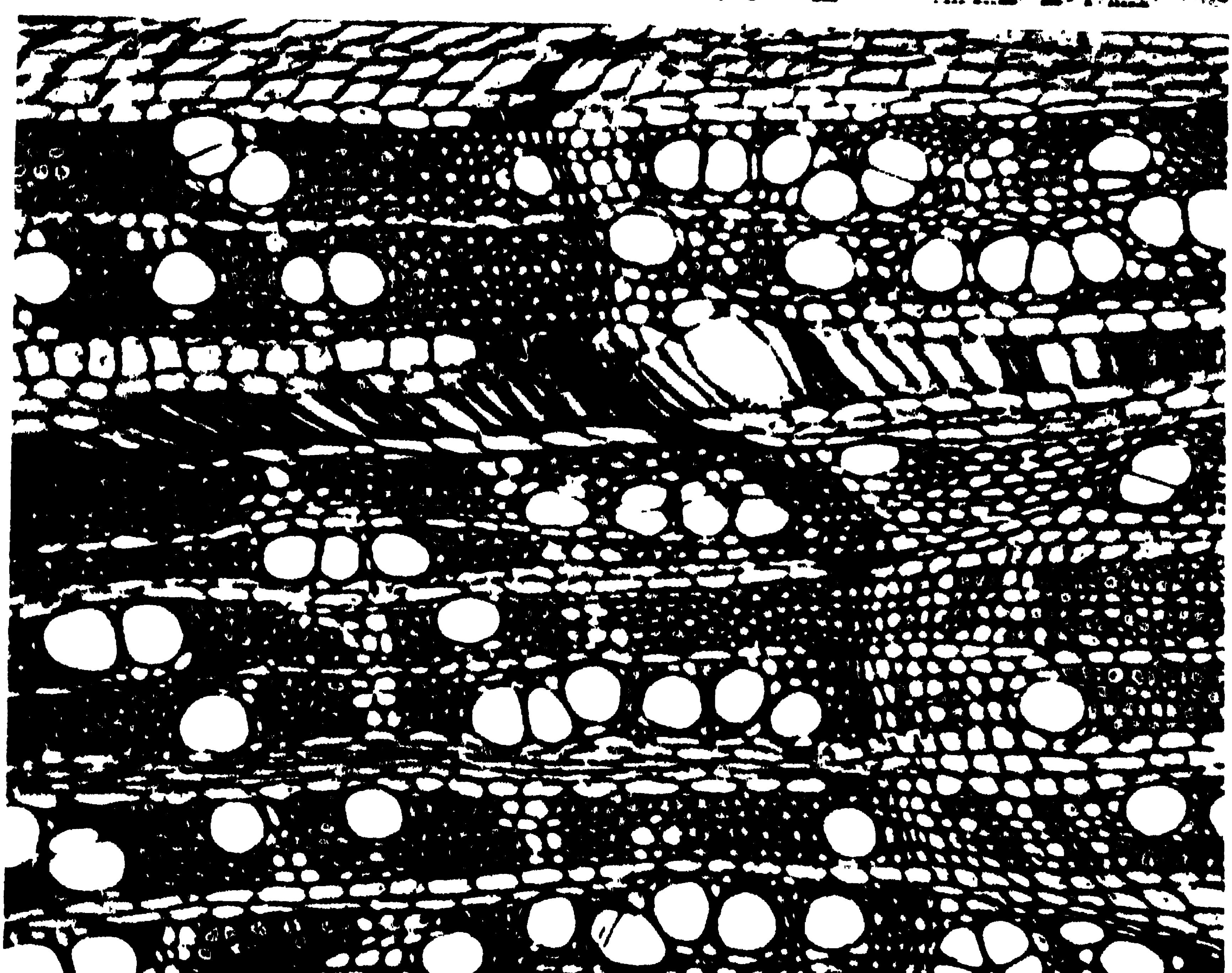


PLATE 13 CERIOPS ROXBURGHIANA ARN.

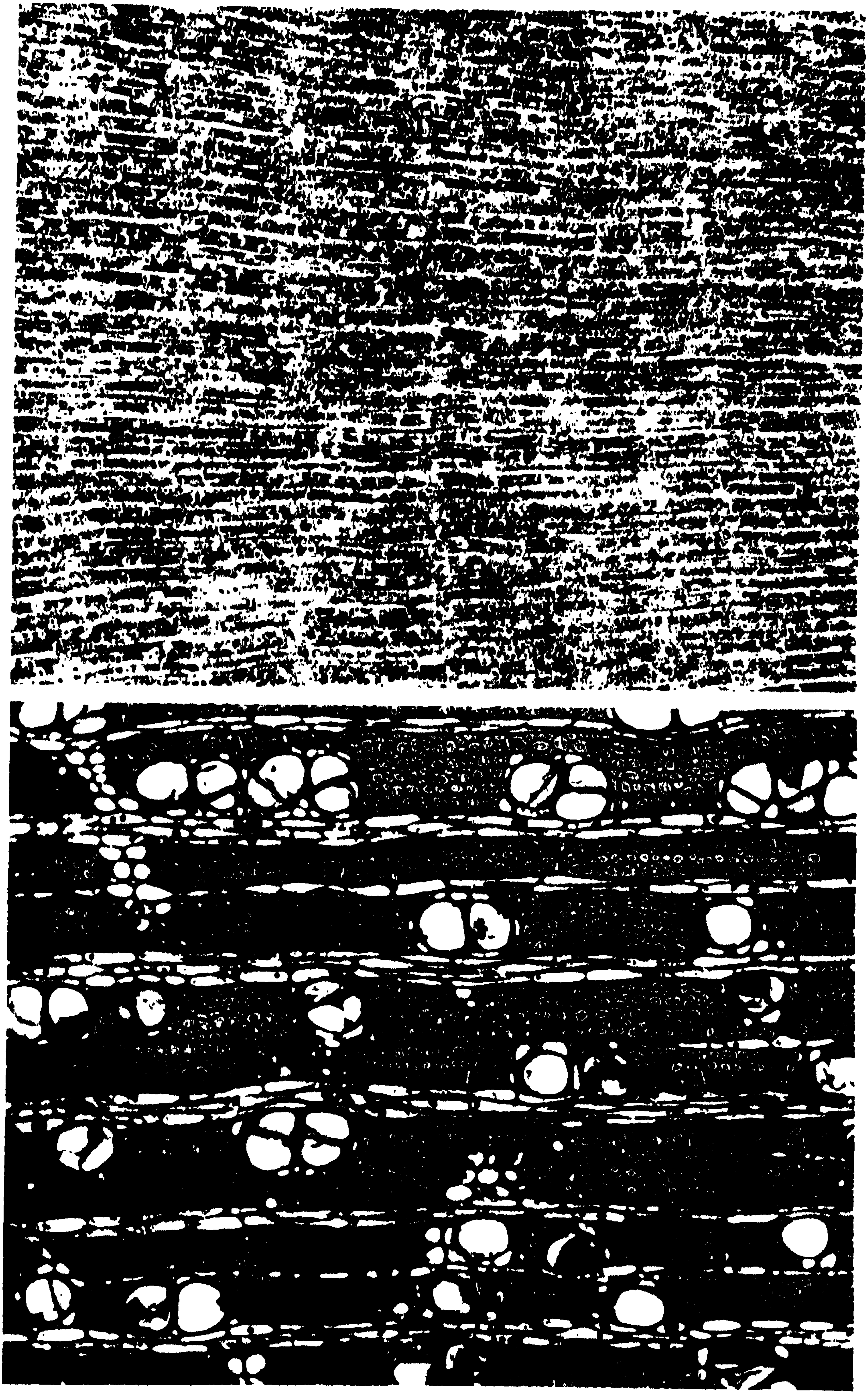


PLATE 14. CERIOPS TAGAL (PERR.) C. B. ROB.

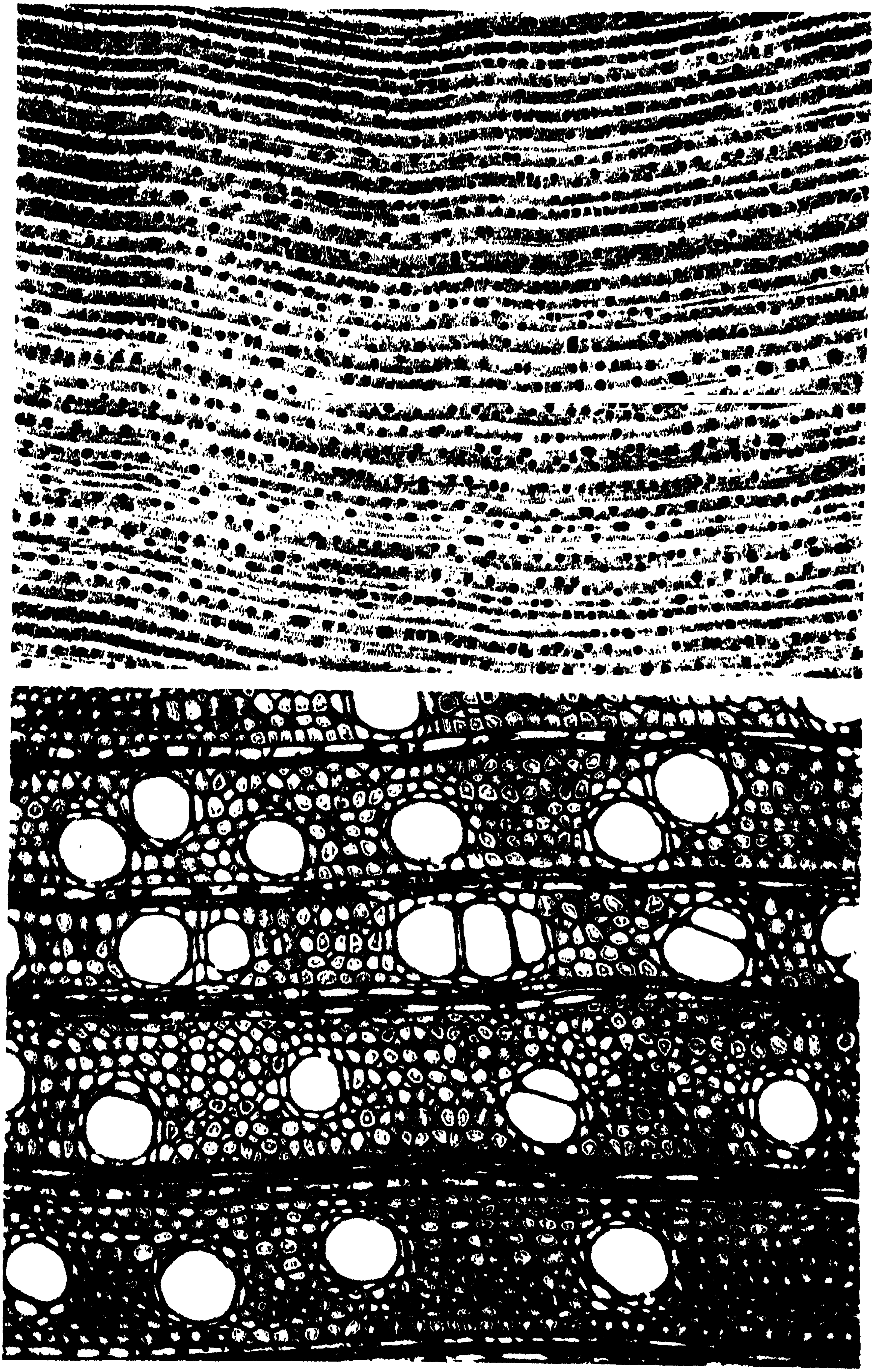


PLATE 15. RHIZOPHORA MUCRONATA LAM.

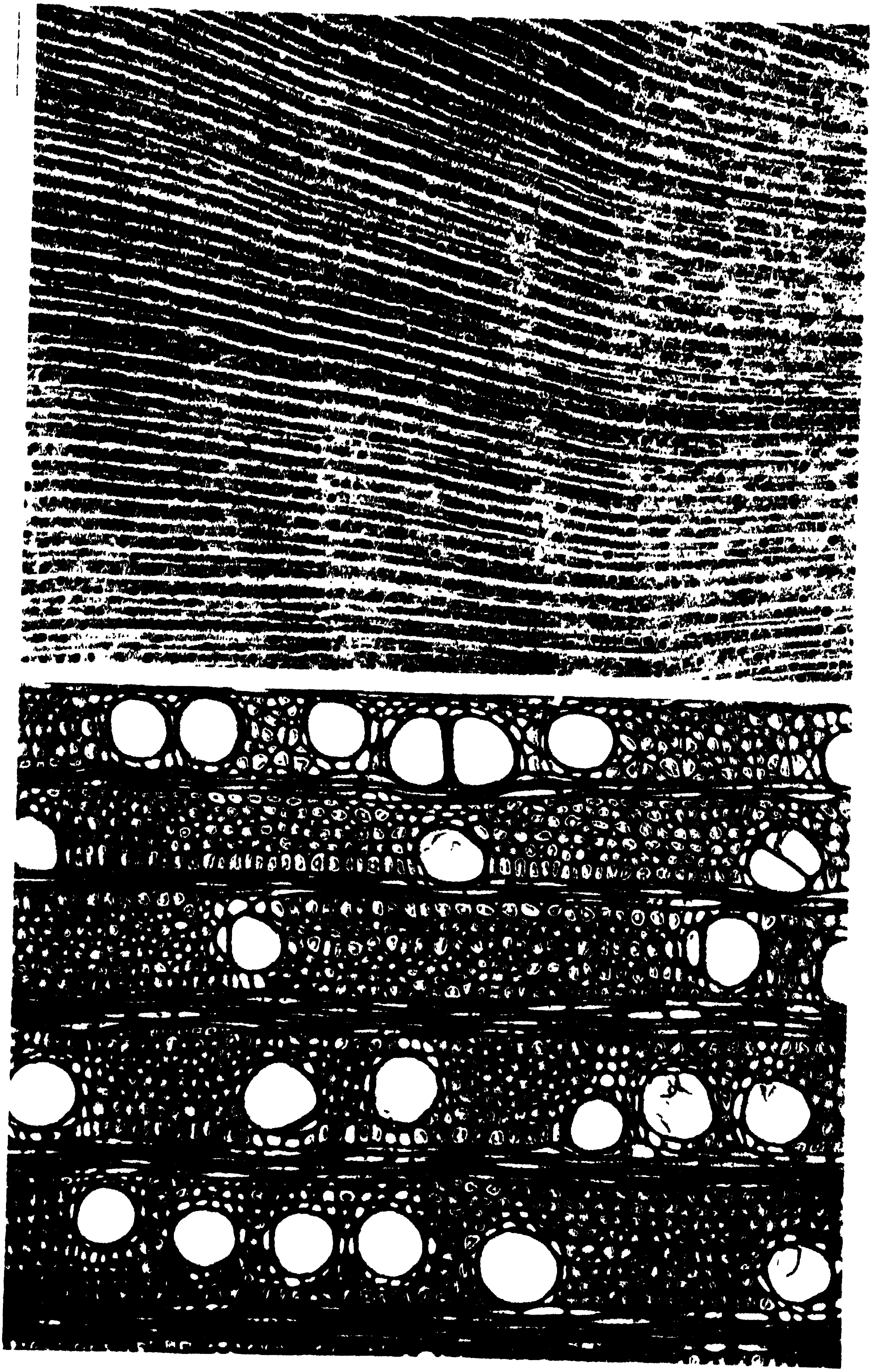


PLATE 16. RHIZOPHORA APICULATA BLUME.

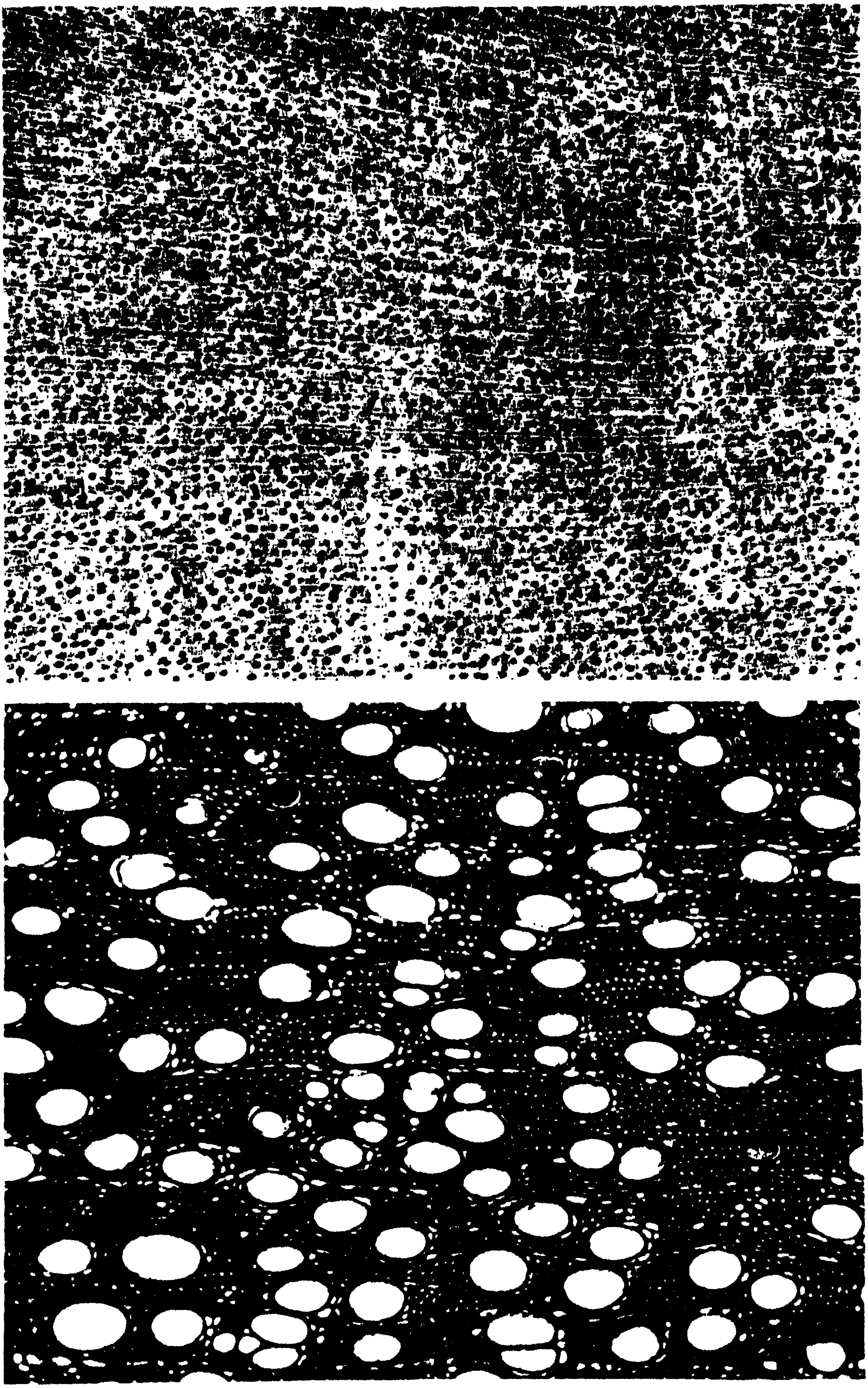


PLATE 17. OSBORNIA OCTODONTA F MUELL.

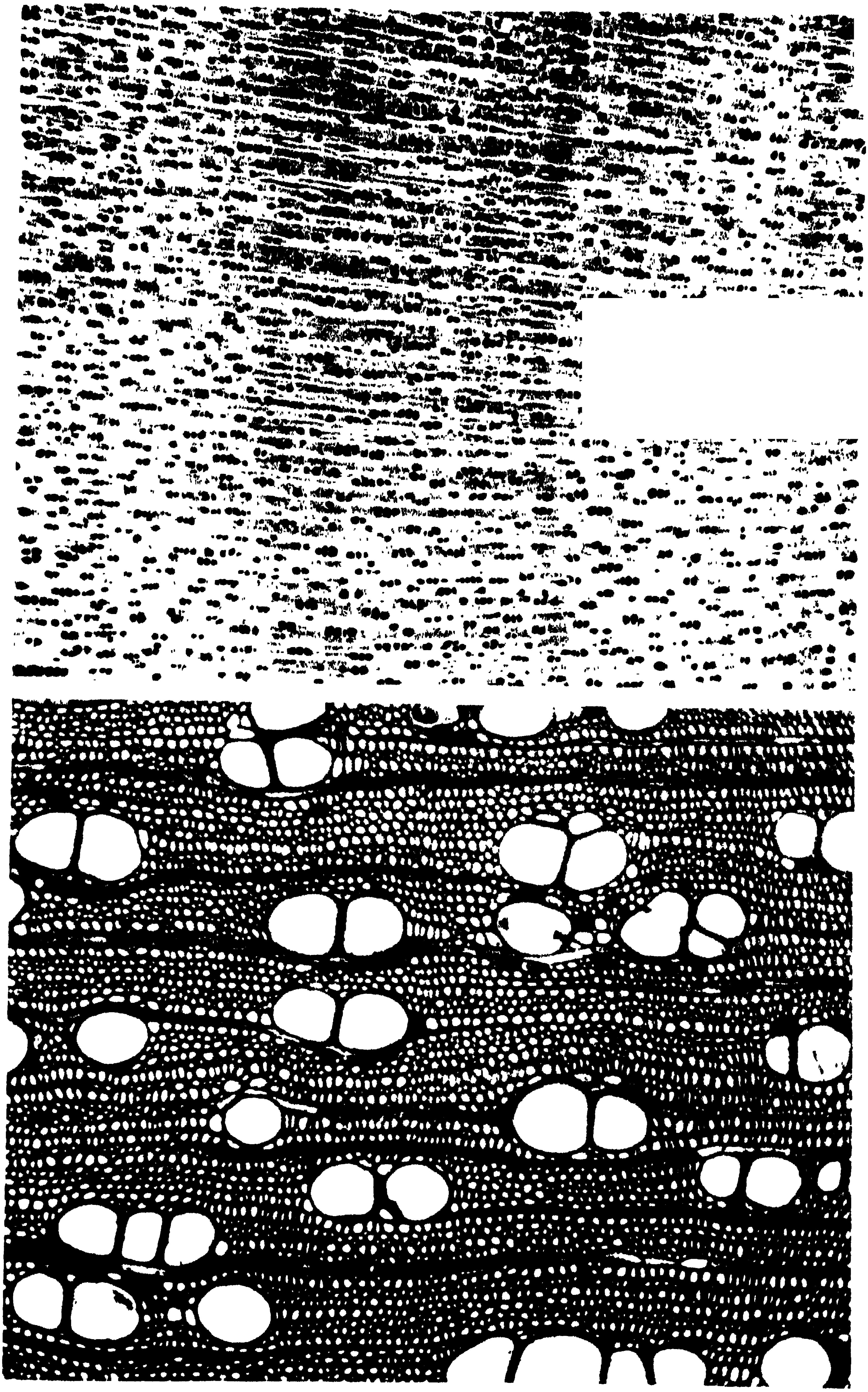


PLATE 18. LUMNITZERA LITTOREA (JACK) VOIGT.

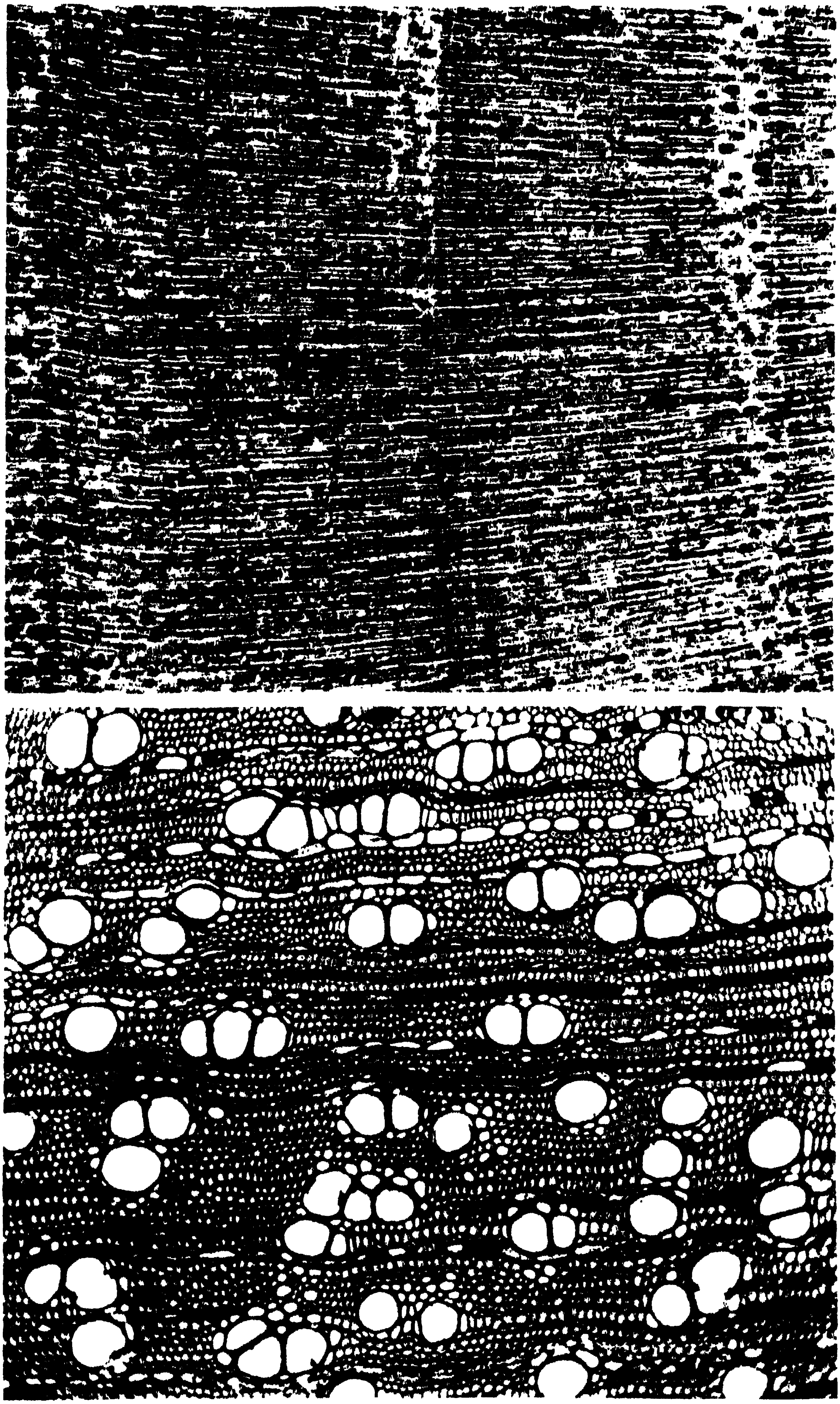
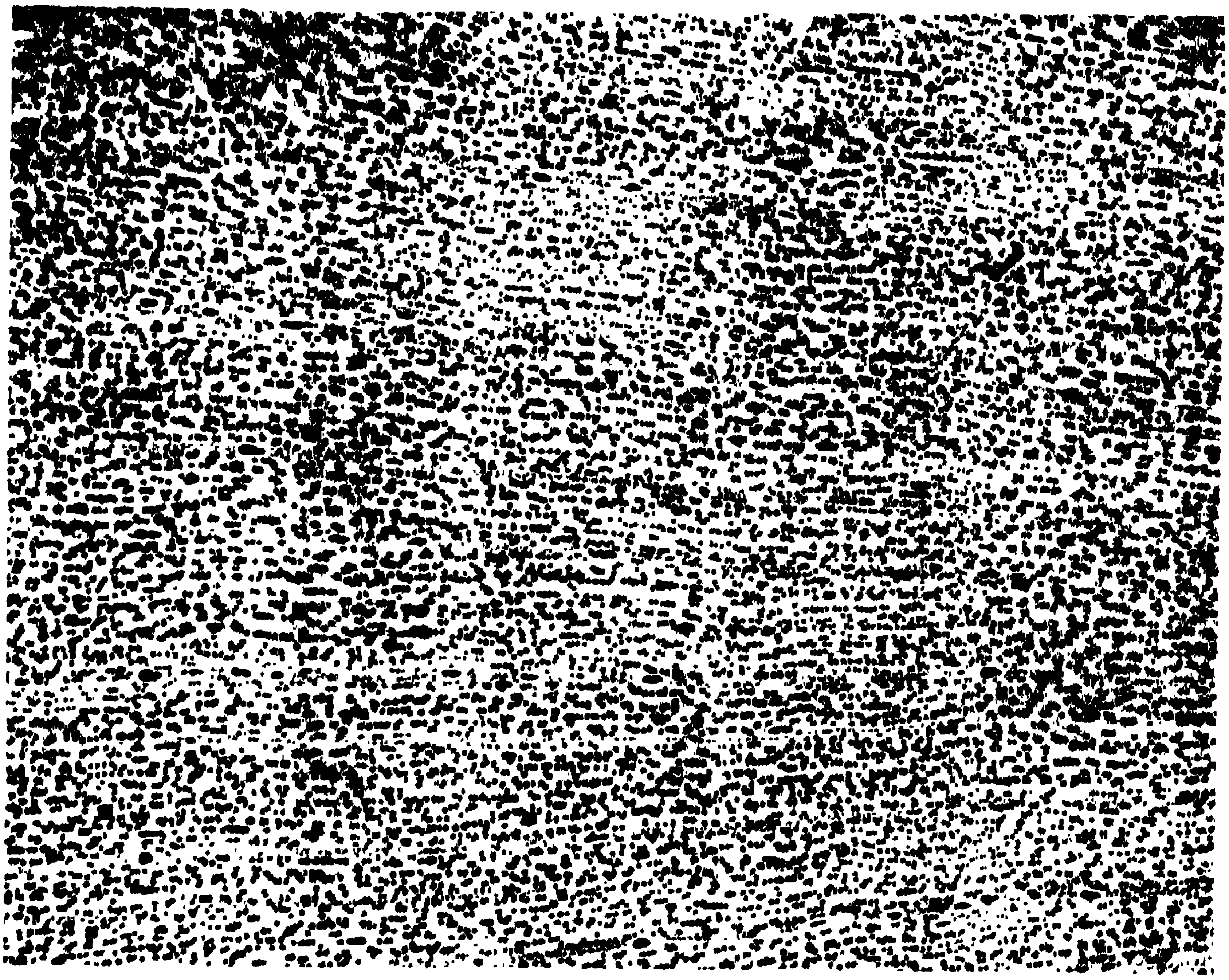


PLATE 19. LUMNITZERA RACEMOSA WILLD.



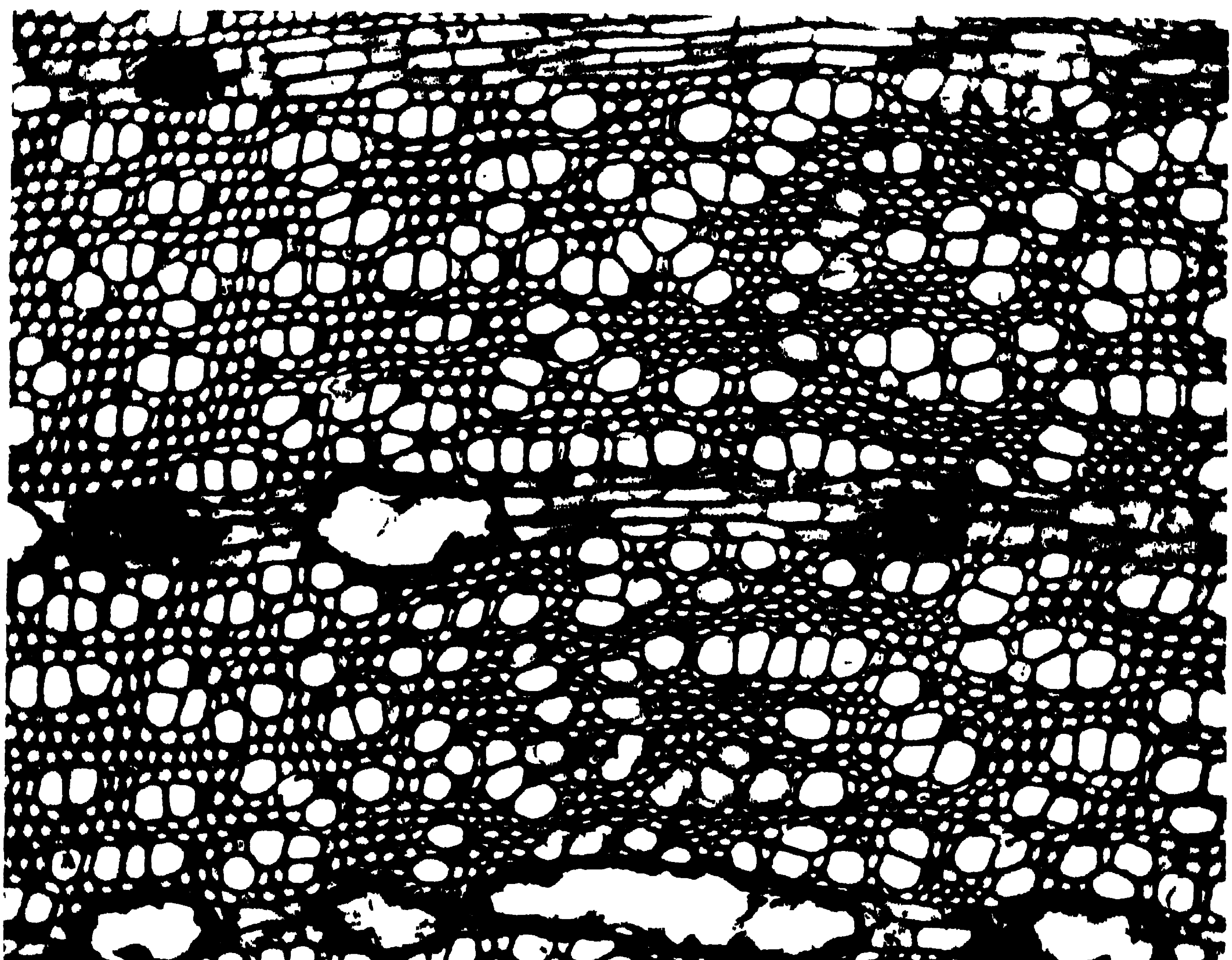


PLATE 20. AEGICERAS CORNICULATUM (LINN.) BLANCO.

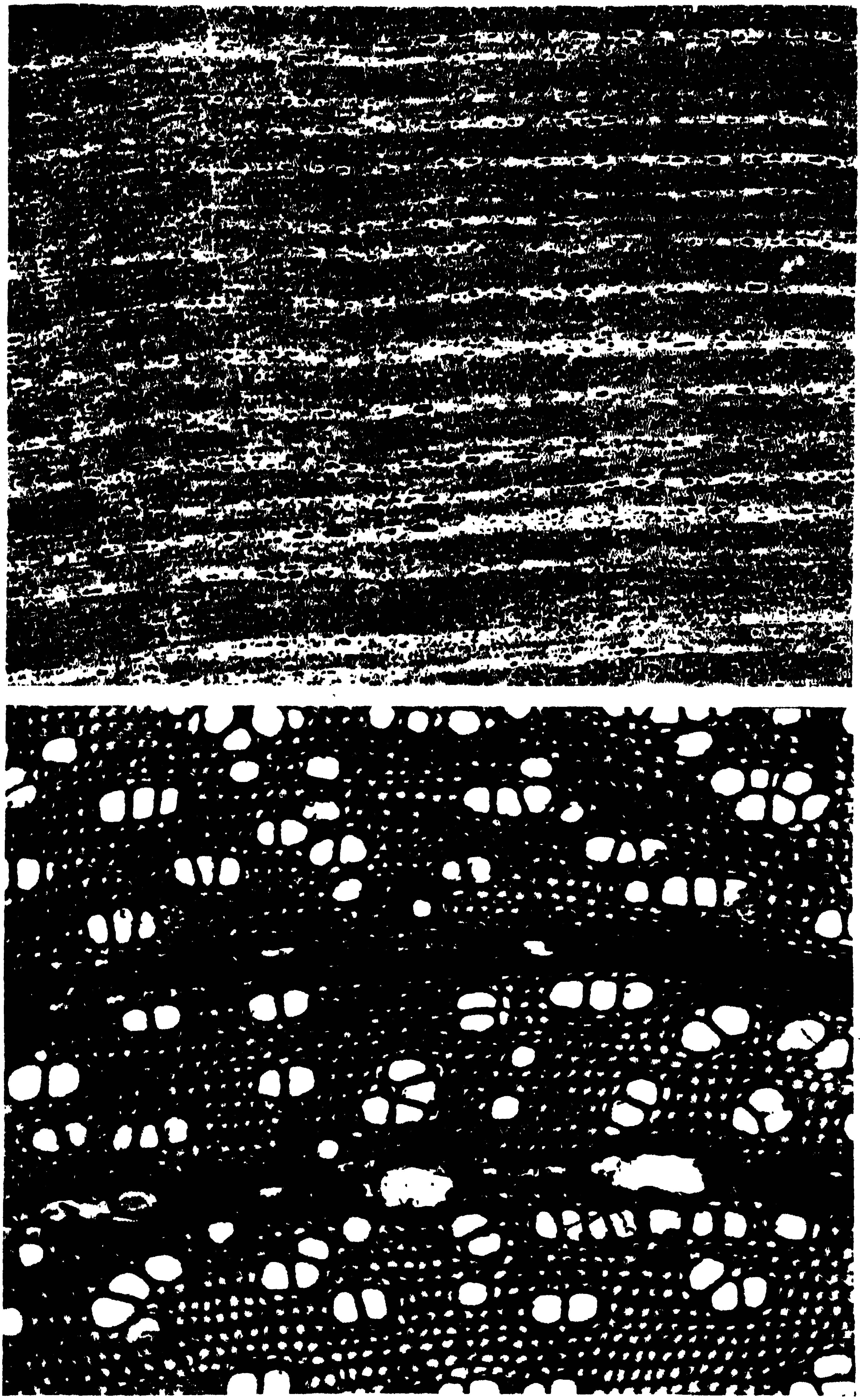


PLATE 21. AEGICERAS FLORIDUM R. AND S.

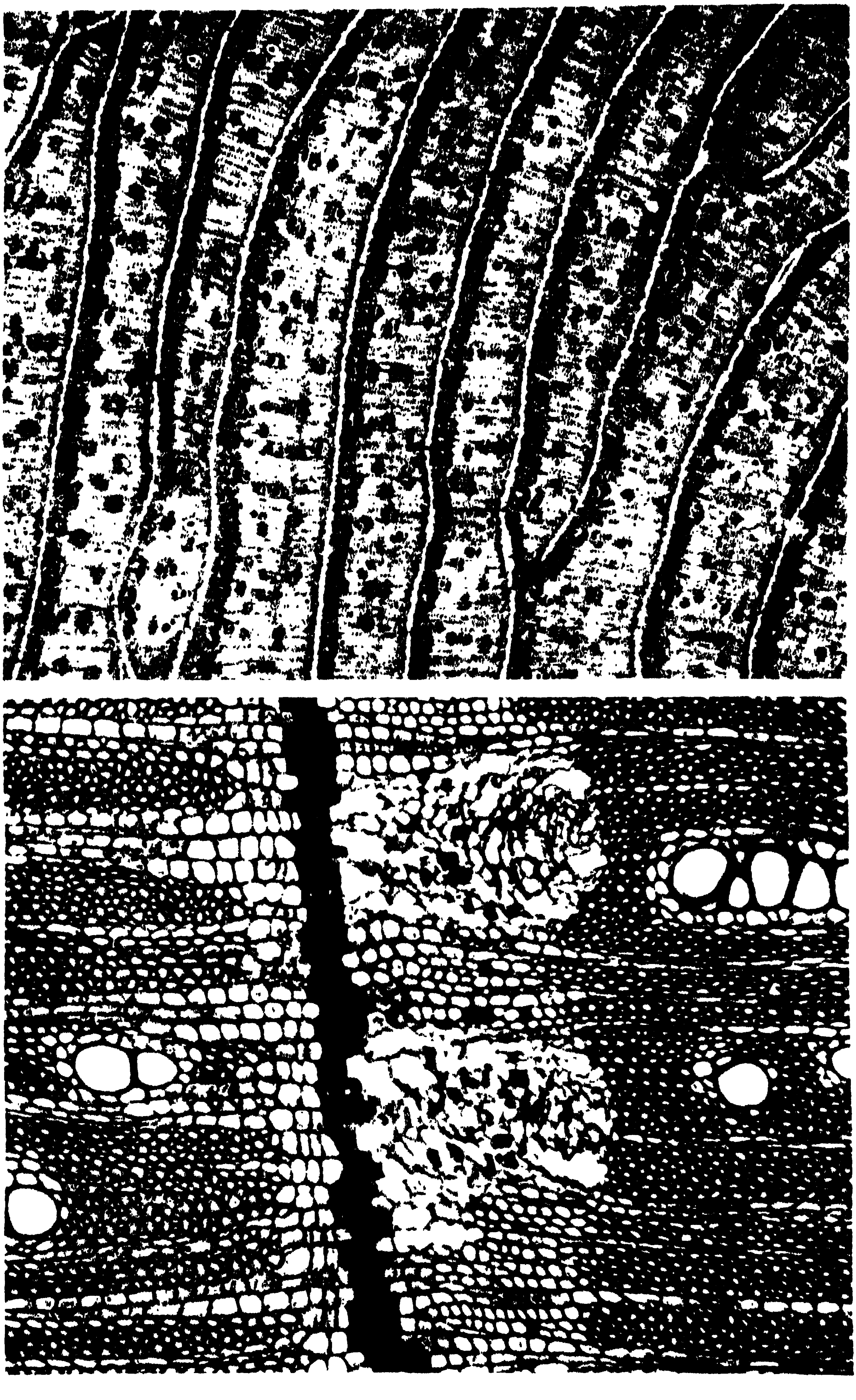


PLATE 22. AVICENNIA MARINA (FORSK.) VIERH

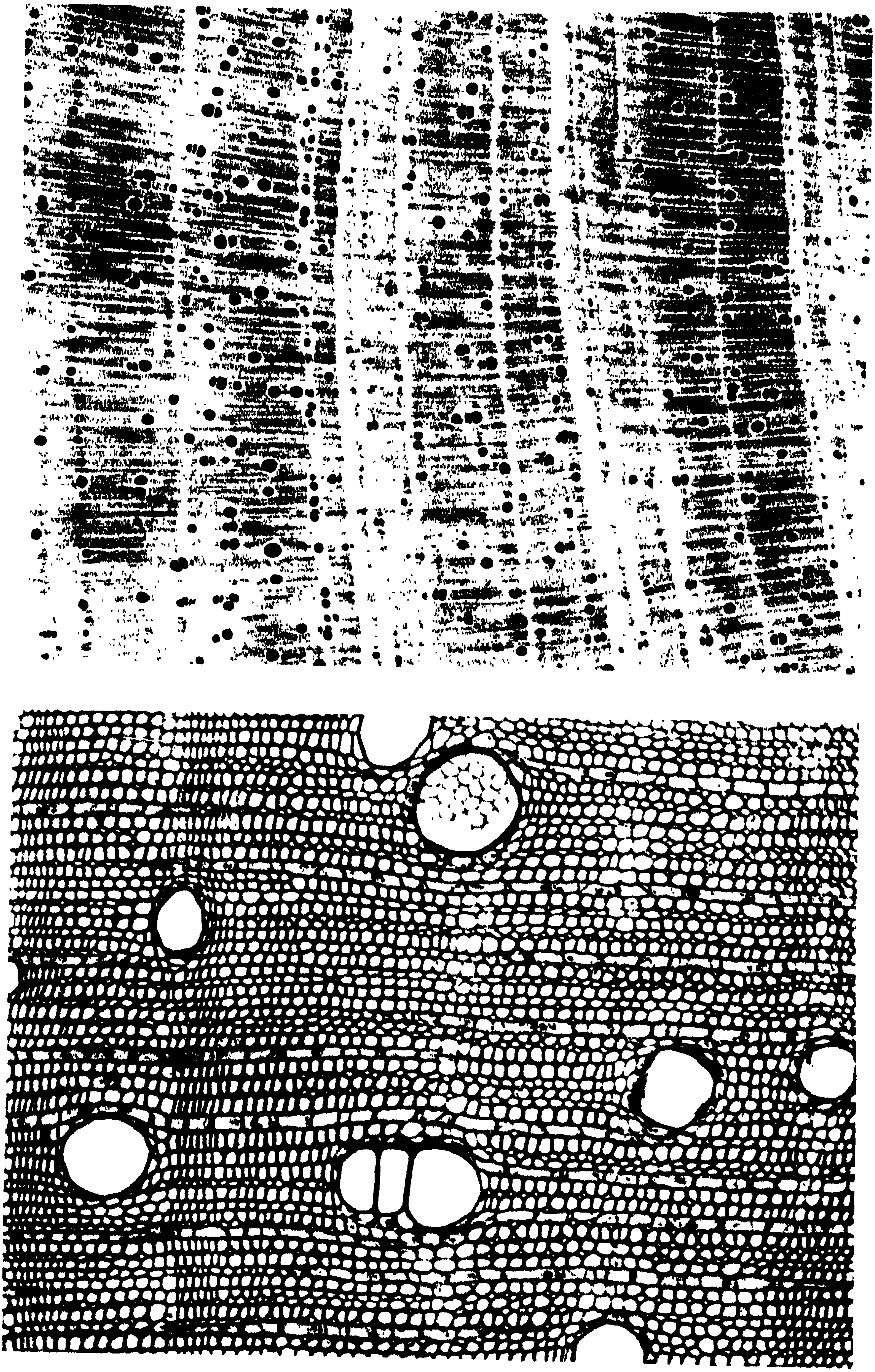
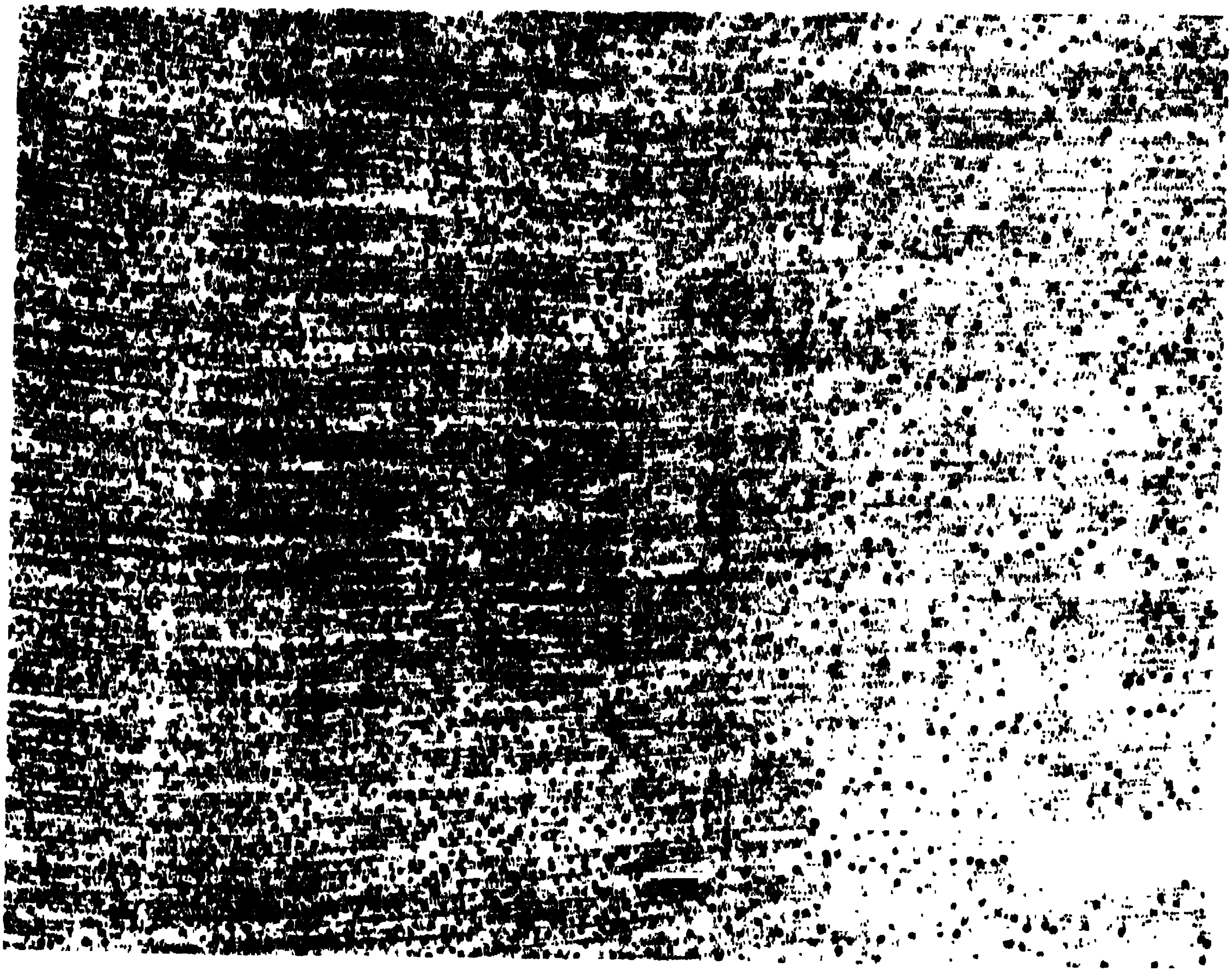


PLATE 23. DOLICHANDRONE SPATHACEA (LINN. F.) K. SCHUM.



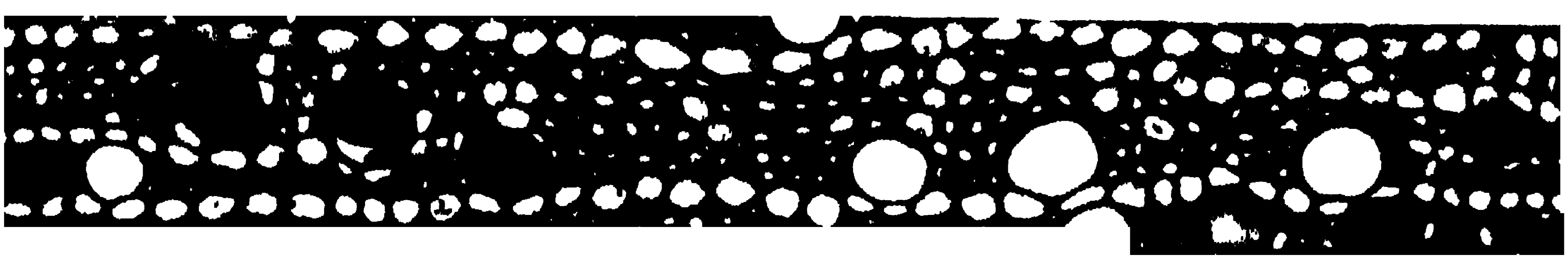


PLATE 24. SCYPHIPHORA HYDROPHYLLACEA GAERTN. F.

ANTHRACNOSE AND IMPORTANT INSECT PESTS OF THE MANGO IN THE PHILIPPINES, WITH A REPORT ON BLOSSOM-SPRAYING EXPERIMENTS

By MACARIO A. PALO[1]

Junior Mycologist, Bureau of Science, Manila

EIGHT PLATES

INTRODUCTION

The mango is the most important and the favorite dessert fruit in the Philippines. It has become very popular because of its aroma and its luscious richness of flavor. Some mango growers in the provinces around Manila not only have extended their orchards but also have established new plantations in order to keep pace with the growing demand for the fruit. As the industry flourishes, the planters are confronted with several troubles that greatly reduce their output. The situation of the mango industry at present is discouraging if no means be found to reduce the enormous discrepancy between the volume of inflorescences produced and the number of fruits that develop to maturity. Field studies and observations made in Batangas, Laguna, Rizal, and Bulacan Provinces have shown that this discrepancy may be attributed to many causes, among which the following are important: The low proportion of complete to staminate flowers on certain trees; the abundance of the hopper pest; the infestation of tip borers; the outbreak of anthracnose; the severity of fruit shedding; and weather factors which may affect the fertilization of the flowers injuriously.

The loss of the crop may be due to one or more of the above factors. In 1930 and 1931 the serious loss of the crop, particularly in Bulacan and Rizal Provinces, was due to a combination of three or more factors, with the hopper pest almost always

[1] The writer wishes to acknowledge the assistance of Dr. C. J. Humphrey, mycologist in charge of plant-disease investigations, Bureau of Science, under whose general supervision the work was carried out. He is also indebted to Dr. W. H. Brown, director, and to Dr. T. G. Fajardo, assistant pathologist, Bureau of Science, for valuable suggestions offered during the course of the work.

gaining predominance. In December, 1930, many of the developing panicles of certain smudged trees in Quingua, Bulacan Province, were noted to have been seriously damaged by the tip borers. The inflorescences that were not destroyed by the tip borers were subsequently damaged by the mango hoppers, and a number of the few fruits that developed on the hopper-infested inflorescences showed the symptoms of anthracnose disease. Added to all these injurious factors was the occasional occurrence of rains which, at the time of blossoming, might affect fertilization injuriously.

FLOWERING HABITS OF THE PHILIPPINE VARIETIES OF THE MANGO AND THEIR RELATION TO PRODUCTION

In the Philippines knowledge of the flowering habits of mangoes is inadequate and is largely based upon general observations. The volume of flowering appears to be influenced by climatic conditions that prevail during the months immediately preceding the blooming season. It was generally observed that the occurrence of rainy weather in November, December, and January does not favor the production of a heavy flower flush in February and March. On the other hand, if these months are dry, the mangoes generally produce heavy inflorescences. This observation conforms to that of Ramachandra Rao(1) for the mangoes of southern India.

The blooming season usually does not exceed a period of three months; namely, February, March, and April. The heaviest flower flush occurs from the middle of February to the middle of March. It was observed occasionally that a few mango trees growing in dry places bear flowers as early as December and January, but the inflorescences produced during these months are relatively few. Likewise, the inflorescences produced in the last wave of flowering, which usually takes place in April but occasionally in May, are few; and many of the fruits that develop from them are abnormal in size and are of less commercial value. In the first wave of flowering many of the trees may be covered almost entirely with inflorescences. These exhaust them to such an extent that such trees frequently do not flower in succeeding months. The heaviest yield of mangoes is always obtained from the first wave of flowering.

It has been the practice in Bulacan Province and in some mango-growing sections of Rizal Province to force the trees to bear fruits off-season by smudging them from morning until evening for eight to twelve or more consecutive days. The

smudge is applied in October, November, and December to trees which are not in leaf flush. At Muntinlupa, Rizal Province, mango trees are sometimes smoked in December, January, and the early part of February. A tree that has been smudged properly frequently produces heavy inflorescence. Such trees do not generally flower again during the blooming season. On the other hand, if the smudged tree produces few inflorescences, it may flower profusely during the blooming period. Owing to the fact that smudging mango trees is done in the months during which pests and diseases are prevalent, generally not more than 10 per cent of those trees give a good harvest.

A normal mango inflorescence produces two kinds of flowers; namely, the staminate, which bear the male character, and the perfect or hermaphroditic, which bear both male and female elements. Although no actual count has been made, it may be presumed from observations of the flowering habits of the different varieties that the proportion of complete to staminate flowers may not be the same for all. In this connection, Popenoe(2) states that mango panicles vary from a few inches to 2 feet in length and carry from two hundred to more than four thousand flowers, of which, in some instances, 2 or 3 per cent are perfect, and in others 60 to 75 per cent. It is doubtful that the relative proportion of perfect to staminate flowers has any correlation with production, but from the theoretical point of view the trees that bear a greater number of complete flowers have a correspondingly greater chance to give a good harvest under equal conditions. This may perhaps be the reason why at Muntinlupa, Rizal, the pico and pahutan varieties produced a far greater number of fruits than the carabao variety when all of them were equally infested by hoppers. The pahutan variety retained as many as fifteen mature fruits, the pico variety up to ten, and the carabao variety generally one to four mature fruits on each panicle.

THE MANGO-HOPPER PROBLEM IN THE PHILIPPINES

The mango hopper is the worst pest of mango inflorescences. It is now of widespread economic importance. The enormous loss in the crops of 1930 and 1931 in practically all the mango-growing sections around Manila was due mainly to the severe infestation of this pest. The enormous loss occasioned by this pest came particularly to the writer's attention in March, 1930, when he observed a heavy destruction of inflorescences on about 50 per cent of the trees in the Hacienda Madrigal at Muntin-

lupa, Rizal Province, including all those that he sprayed with Bordeaux mixture and lime sulphur to protect the flowers from being attacked by anthracnose disease.

In the Philippines the life history of the leaf hoppers on mango inflorescence is not very well known. Specimens of the insects collected at Muntinlupa, Rizal Province, were sent to Dr. L. B. Uichanco, professor of entomology in the College of Agriculture, University of the Philippines, for identification. In his reply under date of July 15, 1931, Doctor Uichanco stated:

> There are two species in your lot. They are as follows: Order Homoptera, family Cicadellidæ, subfamily Bythoscopinæ.
>
> 1. *Idiocerus niveosparsus* Léthierry.—This is the large brown species, about 4.5 millimeters long.
>
> 2. *Idiocerus clypealis* Léthierry.—A much smaller species, only about 3.5 millimeters long, ground color light greenish. Judging from the relative numbers in your samples, it appears that this species is the more abundant of the two.

The greater bulk of the damage noted on the mango inflorescences in Muntinlupa, Rizal Province, is due to *I. clypealis* (Plate 1, fig. 2) since it is far more numerous than *I. niveosparsus* (Plate 1, fig. 1).

After the inflorescence buds have appeared and the developing panicles have grown out to a certain length, the hoppers begin to show their activity in laying eggs. Egg punctures may be noted on the flower stems and buds. Owing to the profuseness of egg laying of the hoppers, the inflorescences may wither and die before the opening of the flowers is completed. It seems as if the egg-laying activity of the hoppers is influenced by the climatic conditions prevailing in the locality. In November and December, 1930, the inflorescences produced by smudged trees in Bulacan Province, particularly in Quingua, Pulilan, and Baliuag, were seriously damaged, owing to the dense oviposition of the hoppers. At Muntinlupa, Rizal Province, it was noted that, owing to the heaviness of egg laying, more than 5 per cent of the developing panicles were heavily damaged during four or five days of cool, cloudy weather following a shower that occurred January 12, 1931. The inflorescences produced in the dry months of March and April, however, were but lightly damaged by the hoppers; consequently a fairly good harvest was obtained in June and July.

It was also observed at Muntinlupa in 1931 that two or more broods of the hoppers occurred before the flowers dropped off. One or two broods sometimes occurred before the opening of

the flowers, and another one or two broods during the blossoming period.

The nymph (Plate 1, fig. 3) feeds on the inflorescence by piercing the tissues with its proboscis and drawing the sap from them. In a severe infestation nymphs may occur by the hundreds or thousands on a single inflorescence, thereby causing it to appear blighted after a few days (Plate 1, fig. 4). When the infested inflorescence is agitated violently the nymphs on the flowers may be seen moving downward to hide on the lower parts of the twigs and lower surfaces of the leaves.

The hoppers excrete droplets of sticky, sweetish, amber-colored fluid known as "honey dew." In severe cases of infestation the inflorescences, as well as the leaves and twigs below them, are covered with this substance. The honey dew has an injurious effect upon the flowers since it prevents their fertilization to a certain extent and at the same time serves as a favorable medium for the growth of sooty mold (*Chaetothyrium mangiferae* Mendoza).[2] Within a brief period following rainy weather the growth of sooty mold on all parts of the tree covered with honey dew may become evident. The black growth of the mold on the leaves and peduncles (Plate 1, fig. 5) may persist until the fruits mature.

When there are no more flowers upon which the hoppers can feed, they migrate to the leaves. On the new leaf flushes, egg punctures made by the hoppers may again be noted on the midribs of leaves and a new hatching of the hoppers may occasionally be observed. In May, the adult hoppers, particularly *I. clypealis*, occur in great abundance on the leaves. Although their number had considerably decreased, still many of them were found on the leaves of a number of trees at Muntinlupa Plantation in July, August, September, and October, 1931. In the second half of September, 1931, when nearly 50 per cent of the trees in this plantation were in flush, egg punctures made by the hoppers were again noted on the midribs and petioles of the young leaves and occasionally on the tender stems. Probably the broods during this time were mostly *I. niveosparsus*, since when several nymphs of different stages were reared on a mango seedling inclosed in a celluloid cylinder with its top covered with cheesecloth, the adults that emerged from the last molting were in all cases *I. niveosparsus*.

[2] Determined by Mr. José Mendoza, associate mycologist, Bureau of Science.

THE ANTHRACNOSE DISEASE OF MANGO

Economic importance.—Anthracnose is the most important fungous disease of the mango. Its epidemic outbreak is largely influenced by high humidity so that in certain years it causes serious loss; in other years it is of practically little economic significance. Wester(3) claimed that "the failure of mango to set fruit may be due to excessive humidity or precipitation during the blooming period, but the cause is more probably the mango blight fungus, which was identified by P. H. Rolfs as *Colletotrichum glœosporioides* Penzig." In 1924, it was reported by the Philippine Bureau of Agriculture(4) to have caused a severe blossom-blight of mangoes in the Islands. Clara(5) describes the disease on the ripening fruits and states that it causes about 39 per cent of the storage decay in this fruit. In 1930 and 1931, anthracnose occurred in the mango-growing sections of Bulacan, Laguna, and Rizal Provinces, but the infection shown on the leaves and occasionally on the flowers and fruits was not severe enough to warrant serious attention. Although anthracnose infection may be light, its occurrence should be feared because it may serve as the source of a severe outbreak when the conditions for its development become favorable. The writer has noted but one instance of heavy anthracnose infection. This occurred on 60 per cent of nearly a thousand seedlings growing in beds beneath the mango trees at Muntinlupa, Rizal Province. A few of these seedlings died of the disease and the rest showed typical anthracnose spots on the leaves (Plate 2, fig. 1). Undoubtedly the trees that sheltered the seedlings served as the source of infection, as these showed symptoms of anthracnose on some of their leaves. The development of the disease on the seedlings was favored by the occurrence of rains, alternating with drizzles, over a period of four days (June 4 to 7, 1931). It may be inferred that the splashing of the rain on the diseased parts of the trees might have transferred the spores of the anthracnose organism to the seedlings beneath them.

Symptoms of the disease.—On the young leaves the incipient stage of the anthracnose disease may be recognized by the development of small, circular, vinaceous-brown [1] or deep brownish vinaceous spots. These spots develop slowly under dry-

[1] The colors indicated here and also in subsequent parts of this paper are those of Ridgway's Color Standards and Color Nomenclature. Washington (1912).

weather conditions. Under humid conditions they form large Mars brown or mummy brown blotches, causing the affected leaves to appear blighted (Plate 3, fig. 1). The blotches may become 20 to 50 millimeters in diameter (Plate 3, fig. 2); the tissues around the affected parts are deep olive-buff. White mycelial threads (Plate 2, fig. 2) and light ochraceous-buff to salmon-buff masses of spores may develop on the surface of the blotches under humid conditions. On the leaves the disease may be found commonly associated with injuries caused by scale insects, certain beetles, and midges. The midge larvæ mine the leaves and form small galls on them (Plate 3, fig. 4). After the larvæ have left the leaves, in order to pupate in the soil, the injuries caused by them on the leaves develop into spots and subsequently into shot holes (Plate 3, fig. 5). The anthracnose organism may frequently be isolated from such injuries.

Anthracnose attacks also the tender shoots and stems of seedlings, forming at first small, circular, or slightly oblong, spots (Plate 4, fig. 1), which may later develop into large dusky brown or blackish brown blotches. Wither tip (Plate 4, fig. 2) or die-back resulting from the attack of anthracnose is of rare occurrence. The drying of the young shoots is commonly a result of the merging together of the blotches which, in serious attacks, may cause the dying of all the tissues above the affected parts.

On the inflorescence the earliest recognizable symptoms of the disease is the production of blackish brown specks on the peduncles and flowers. In case of severe attack the flowers are distinctly blighted (Plate 3, fig. 3). This blighting is sometimes so very rapid that its incipient stages may escape observation. The infected flowers fall off, leaving the more-persistent spikes (Plate 3, fig. 6) on the peduncles.

Anthracnose attacks the young as well as the ripening fruits, but is rarely observed on pre-maturing ones. It is commonly observed blighting, and subsequently blackening, the newly-set fruits (Plate 4, fig. 3). Infection on these is believed to be a continuation of the progress of the disease on the flowers. The disease may also attack 20- to 30-day-old fruits, forming on the rind small, circular, blackish brown spots (Plate 4, fig. 4), which may merge together or enlarge into slightly depressed blotches (Plate 4, fig. 5). On the ripening fruit the disease occurs as sunken, blackish brown blotches upon which salmon-buff masses of spores develop (Plate 4, fig. 6).

Causal organism.—The anthracnose disease of mango is caused by the *Gloeosporium* stage of *Glomerella cingulata* (Stonem.) S. and v. S., of which there appear to be several strains of a single species.

Cultures of the organism from different isolations do not always display the same characters of mycelial growth even on the same medium. The growth may be flat or it may be slightly or largely aërial. It may be white or nigrescent. Some cultures are dark, while others are light or may assume various shades of gray. Again, some cultures develop abundant salmon-colored masses of spores; others produce few or none at all.

The fungus develops pustular acervuli on the diseased parts of the stem (Plate 6, fig. 4) and leaves. An acervulus (Plate 5, fig. 2) forms beneath the epidermis, and as it develops it ruptures the epidermis and exposes the spores. The conidiophores are hyaline, nearly filiform, and generally short. They generally arise from the stromatic layer of fungous structure. In culture they may also be borne either singly or as lateral outgrowths of the hyphæ (Plate 5, fig. 4) or in groups arising from a hyphal cell (Plate 5, fig. 6). Interspersed occasionally with the conidiophores in an acervulus are long, stiff, fuscous-black setæ (Plate 5, fig. 3). These are generally 2- to 3-septate, wider at the base and gradually tapering towards the tips. In some cultures they are produced abundantly, but in others they are either few or entirely lacking. The spores are borne on the tips of the conidiophores. They are single celled, hyaline, and elliptical to oblong (Plate 5, fig. 5). From various culture media they measure 8.3 to 27.4 μ in length and 2.0 to 6.6 μ in width. On the average they are 14.2 μ long and 4.4 μ wide. They are finely and uniformly granular while young, but with age they become prominently vacuolate. They are produced in masses on the surface of the lesions and may behave likewise on the culture medium. Since they adhere to one another, they are not well adapted to wind dissemination. Some cultures isolated from mango produce black, stromatoid bodies (Plate 5, fig. 1), which when sectioned show nothing but a mass of interlaced hyphæ.

When a number of mango seedlings in leaf flush were sprayed with a spore suspension, the symptoms of anthracnose disease were produced on the young leaves (Plate 6, fig. 3) and occasionally on the tender stems. The control seedlings remained clean and healthy. Under greenhouse conditions and in the presence of much moisture the disease causes the blighting of

the young leaves of the inoculated seedlings within four days. It may spread downward to the stem, upon which are developed numerous acervuli (Plate 6, fig. 4) and abundant masses of spores.

OBSERVATIONS ON THE FRUIT SHEDDING OF MANGOES AT MUNTINLUPA, RIZAL PROVINCE

The shedding of mango fruits at Muntinlupa was severe in 1931. It is estimated that not more than 5 per cent of the newly-set fruits on certain trees reached maturity, the greatest amount of fruit fall taking place before the fruits attained a length of 30 millimeters. It then gradually decreased as the fruit approached maturity. The first to fall were the unfertilized pistils, and also those weakened by the hoppers. This was followed by a number attacked by anthracnose and by a few spotted and mummified fruits (Plate 4, fig. 7), the cause of which is still unknown. This unknown trouble was at first mistaken for anthracnose, but tissue isolations from the diseased parts of the fruits were all negative. A number of the diseased fruits were placed in a moist chamber but, again, no fungous growth developed on the lesions.

The great majority of the fruits that were shed within twenty-five to thirty days after setting appeared normal. They did not show any evident fungous lesion or insect injury. It was noted in one instance that as many as fifty-two young fruits of the pico variety were counted on a single panicle, but after a month only two were left to mature. The rest were weeded out. This phenomenon of natural thinning out of the fruits is believed to be a physiological trouble. Popenoe(2) in his studies of mango sterility has concluded that the problem is a physiological one, connected with nutritional conditions, as influenced by changes in soil moisture and food supply, principally the former. Ramachandra Rao(1) reports that the deficient soil nutrition, coupled with adverse climatic factors, such as the dry season, while the mangoes are in blossom do not allow sufficient nourishment for a great number of fruits, and consequently many are weeded out. He supported this idea by observational evidence, stating that the trees are able to retain a larger number of fruits if good summer rains are received, if irrigation is given after the fruits have set, and if the soil-moisture is assured by suitable cultural methods.

Another physiological cause of fruit fall of mangoes is the cracking of pre-maturing and maturing fruits. These cracks

are generally longitudinal (Plate 6, fig. 1). They appear dry, with the exception, in some cases, of a flow of a small amount of sap coming from the injured tissues. Rot organisms invade these injured tissues and cause them to fall away.

A number of fruits may also shed owing to the attack of caterpillars which bore into them. The pest may be recognized by the presence of an exudate coming from the wound made by the caterpillar, which as it progresses covers itself with excrement and refuse. The occurrence of maggots in a few fruits showed that certain flies bred in them. The maggots entered perhaps through bruises on the rind. The injuries made by both the caterpillars and maggots favor the development of rot organisms and the fruits subsequently rot and fall away.

MANGO TIP BORER ANOTHER FACTOR OF LOSS

The mango tip borer[4] (*Chlumetia transversa* Walker) is widespread in all the central and southern provinces of Luzon. It was noted to have caused damage to about 25 per cent of the inflorescences on certain trees in the Barrio of Dampol in Quingua, Bulacan Province. On other trees the infestation was so light that sometimes only 0.5 per cent of the total volume of inflorescence was damaged. At Muntinlupa, Rizal Province, it damaged on the average about 10 per cent of the panicles that developed on trees smudged in January, and about 2 to 4 per cent of the panicles produced during the normal blooming season.

The injury is produced by the larva, which enters at or about the apices of the developing panicles and then tunnels its way into the central part, forming a cavity in it and causing the upper spikes and spikelets to shrivel and dry. If it tunnels its way down to the base of the panicle the entire inflorescence may die. This pest attacks also the young shoots (Plate 6, fig. 2) of the new flushes, causing the shrivelling and drying of the top parts. The dying of the shoots means a reduction of the flowering area in the succeeding blooming period. September 25, 1931, the tip-borer-infested young shoots in every hundred counted on one portion of each of the twelve trees in flush at Muntinlupa Plantation varied from 11 to 50 per cent, with an average of 29 per cent.

[4] Mr. Pedro Sison, assistant entomologist of the Bureau of Plant Industry, is familiar with this pest. He informed me that it is the larva of *Chlumetia transversa* Walker.

PRELIMINARY REPORT ON MANGO-BLOSSOM SPRAYING EXPERIMENTS AT MUNTINLUPA, RIZAL PROVINCE

SPRAYING EXPERIMENTS OF 1930

The first spraying experiments were conducted in February and March to determine three points; namely, the efficacy of Bordeaux-mixture and lime-sulphur sprays in preventing anthracnose infection on the inflorescences, the strength of spray necessary to obtain the desired results, and when to apply the spray and the intervals between applications. Trees that showed anthracnose disease on the foliage were selected for these experiments. The sprays were applied with a bucket spray pump fitted with an 18-meter hose. An effort was made to cover the leaves and panicles with a thin coating of the sprays. While the experiments were progressing the inflorescences of the sprayed trees were unexpectedly attacked severely by hoppers when the flowers were beginning to open. As a result, the inflorescences of the treated and the check trees were equally damaged. However, a few things were learned from these experiments. It was found that lime sulphur in a dilution of 1 : 50 up to 1 : 30 and Bordeaux mixture in strengths of 2 : 4 : 50, 3 : 4 : 50, and 4 : 4 : 50 do not have any injurious effect upon the mango inflorescences if given before the opening of the flowers.

SPRAYING EXPERIMENTS OF 1931

Condition of the smudged trees in flower before the spraying experiments of 1931 were started.—In December, 1930, a trip was made to Muntinlupa, Rizal, with the view to securing additional data on the hopper infestation in that locality. A few smudged trees were in flower. It was noted that the hoppers occurred in great abundance on the inflorescences. The tip-borers which formed cavities in the panicles were also noted to have shared prominently in the destruction of the inflorescences. Anthracnose occurred also, and, although the infection was light, it was feared that it might become a source of a severe outbreak under favorable weather conditions. Owing to the fact that the inflorescences which had been smudged in December were damaged by a variety of factors, the use of combination sprays in subsequent experiments was resorted to so as to bring as many of those factors under control as possible.

Methods of spraying.—The spraying experiments were conducted in an orchard at Hacienda Madrigal in Muntinlupa, Rizal,

from January to March, but the observations were continued until July. The orchard consisted of a mixture of carabao, pico, and pahutan varieties. The trees, which were about a hundred in number, were all normally bearing and varied from 10 to 15 meters in height, with crowns 11 to 18 meters in diameter. About sixty trees in this orchard were forced to bear flowers by smudging. Trees of the carabao variety which showed a more or less uniform distribution of the inflorescence buds on their crowns were used. The sprays were applied over an experimental area of 15 to 25 square meters on each tree. The other portions of the crown were used as controls.

The spraying outfit consisted of a Gould's New Combination Hand Sprayer No. 1640 with a 9-meter hose, the nozzle of which was tied to a light 4-meter bamboo rod. Two laborers were required in spraying, one operating the pump, which was mounted on a stage made of wood, and the other applying the spray to the inflorescences, leaves, and twigs. The higher parts of the side branches were sprayed with the aid of the bamboo rod and a 3-meter bamboo ladder provided with props.

Bordeaux mixture and lime sulphur were the principal sprays used, but to these were added either nicotine sulphate or lead arsenate, or both, for the control of insects. Chinese soap and nicotine sulphate were also introduced in the Bordeaux-mixture series.

A clue as to the best time of application developed from a preliminary trial in which the writer failed to prevent severe infestation of hoppers by spraying weekly two mango trees of the pico variety with 3 : 4 : 50 Bordeaux mixture to which nicotine sulphate (Blackleaf 40) was added at the rate of 1 to 800 parts of the spray. In this preliminary trial the inflorescences (Plate 7, fig. 1) appeared healthy until the third spraying despite the fact that they were slightly weakened by the abundant egg-laying of the hoppers. The spray did not show any burning effect upon the flowers (Plate 7, fig. 2). The eggs of the hoppers began to hatch a day after the third spraying, and within three days after the appearance of the first hatching the flowers were found swarming with the nymphs of the hoppers, the majority of the inflorescences being severely damaged before the date of the fourth spraying. The inflorescences which were partially damaged developed young fruits only on their apices after the fifth spraying. Nearly all of the inflorescences of the control tree were damaged. One of these inflorescences is

shown in Plate 7, fig. 3. Two things were shown in this trial; namely, that Bordeaux-nicotine sulphate is useless as a spray for the adult hoppers, and that weekly sprayings may not prevent a severe infestation of the hoppers, especially if new hatchings of the hoppers occur immediately after the application of the spray. Having known that weekly sprayings will not help much in preventing severe infestation of the hopper nymphs, it was then planned to apply the spray containing the nicotine sulphate while the new broods were hatching.

In subsequent sprayings (Table 1), in which Bordeaux mixture was the chief fungicide, five applications were made as follows:

1. A preliminary spray of 5 : 5 : 50 Bordeaux mixture, to which lead arsenate powder (1.5 pounds to 50 gallons of Bordeaux mixture) was added, was given when the inflorescence buds were bursting, in order to protect the developing panicles from an early attack of anthracnose and tip borers.
2. A second spray of 3 : 4 : 50 Bordeaux mixture, to which nicotine sulphate (1 to 800 parts of the spray) and lead arsenate powder (0.8 pound to 50 gallons of the mixture) were added, was given before the opening of the flowers, to prevent further attack of anthracnose and tip borers, and also the hoppers, in case a brood occurred within this period.
3. A thorough spray of nicotine-soap solution was given when a new brood of the hoppers was noticed.
4. The third spray was repeated within three to six days when further hatchings were noticeable.
5. The fifth spray consisted of a repetition of the second spray. It was given when the petals were withering, in order to protect the young fruits from the attack of anthracnose, hoppers, and certain insects.

In a second series (Table 2) lime sulphur, which has both fungicidal and insecticidal properties, was used instead of Bordeaux mixture to prevent anthracnose infection. In this series four sprayings were made as follows:

1. A preliminary spray of lime sulphur, 3° Beaumé, to which lead arsenate powder (1.5 pounds to 50 gallons of lime-sulphur spray) was added, was given while the inflorescence buds were bursting, in order to protect the developing panicles from the attack of anthracnose and tip borers.
2. A second spray of lime sulphur, 1.28° Beaumé, to which nicotine sulphate (1 to 800 parts of lime-sulphur spray) and lead arsenate (0.8 pound to 50 gallons) were added, was given before the flowers began to open, or when the first brood of the hoppers occurred.
3. A third spray of lime sulphur-nicotine sulphate was given when further hatchings were noticed.
4. The last spray was the same as the second. It was given when all of the flowers had opened.

TABLE 1.—*Schedule and results of spraying the inflorescences of carabao mango trees for hoppers, tip borers, and anthracnose, using strong Bordeaux-lead arsenate as the preliminary spray.*

	Tree No. 1	2	3	4	5	6	7	8	Average for all trees.
Treatments and dates of applications:									
First spraying—									
Bordeaux mixture (5:5:50), 50 gallons. Lead arsenate powder, 1.5 pounds	Jan. 19	Feb. 1	Feb. 1	Feb. 10	Feb. 19	Feb. 24	Feb. 24	Feb. 24	
Second spraying—									
Bordeaux mixture (3:4:50), 50 gallons. Nicotine sulphate (blackleaf 40) 0.625 pound. Lead arsenate powder, 0.8 pound	Jan. 31	Feb. 11	Feb. 11	Feb. 19	Mar. 1	Mar. 6	Mar. 6	Mar. 6	
Third spraying—									
Chinese soap, 1.5 pounds. Nicotine sulphate (blackleaf 40), 0.625 pound	Feb. 4	Feb. 15	Feb. 15	Feb. 24	Mar. 6	Mar. 11	Mar. 12	Mar. 10	
Fourth spraying—									
As in the third spraying	Feb. 9	Feb. 20	Feb. 20	Feb. 28	Mar. 9	Mar. 15	Mar. 15	Mar. 15	
Fifth spraying—									
As in the second spraying	Feb. 13	Feb. 25	Feb. 25	Mar. 3	Mar. 12	Mar. 20	Mar. 20	Mar. 20	
Number of mature fruits produced on 3-square-meter portions of the crown:									
Totals—									
Treated	76-29-48 51-24-41	19-14-17	19-34-30	93-36-46	45-29-42	12-17-30	14-8-8	6-3-0	
Checks	7-10-5 0-3-4	4-6-2	7-2-7 3-2	8-0-11 12-8	6-9-4-4	0-0-0	1-0-0	0-0-0	
Average—									
Treated	44.0	16.6	27.6	55.0	38.6	19.6	10.0	3.0	26.8
Checks	4.8	4.0	4.2	7.8	5.7	0.0	0.3	0.0	3.35
Weather observations	[a]		[b]	[c]	[d]				

[a] January 29. Continuous shower at dawn followed by a drizzle in the forenoon.
[b] February 12. Shower for about half an hour. Day cloudy and cool.
[c] February 23. Shower for about two hours.
[d] March 19. Continuous shower from midnight, followed by heavy rain in the morning and then followed by continuous shower until midday.

TABLE 2.—*Schedule and results of spraying the inflorescences of carabao mango trees for hoppers, tip borers, and anthracnose, using strong lime sulphur-lead arsenate as the preliminary spray.*

	Tree No. 9	10	11	12	13	14	15	16	17	Average for all trees.
Treatments and dates of applications:										
First spraying—										
Lime sulphur (3° Beaumé), 50 gallons. Lead arsenate powder, 1.5 pound	Feb. 3	Feb. 3	Feb. 14	Feb 25	Feb. 25	Mar. 2	Mar. 2	Mar. 2	Mar. 1	....
Second spraying—										
Lime sulphur (1.28° Beaumé), 50 gallons. Nicotine sulphate (black-leaf 40) 0.625 pound. Lead arsenate powder, 0.8 pound	Feb. 17	Feb. 17	Feb. 24	Mar. 6	Mar. 6	Mar 12	Mar. 12	Mar. 12	Mar. 14	....
Third spraying—										
Lime sulphur (1.28° Beaumé), 50 gallons. Nicotine sulphate (black-leaf 40), 0.625 pound	Feb. 21	Feb. 24	Feb. 28	Mar. 16	Mar. 16	Mar. 16	Mar. 16	Mar. 15	Mar. 17	....
Fourth spraying—										
As in the second spraying	Feb. 25	Mar. 1	Mar. 5	Mar. 20	Mar. 20	Mar. 20	Mar. 20	Mar. 20	Mar. 20	....
Number of mature fruits produced on 3-square-meter portions of the crown:										
Totals—										
Treated	30–30–13	25–32–33	43–55 45–52	12–10	8–10	12–14	17–14	15–14	19–22–19	....
Checks	0–5–0–3	8–0–3–5	5–0–2 7–5–4	0–0	0 0	1–0–1	0–2–0–2	2–1–0	0–0–2	....
Average—										
Treated	24 3	30 0	48 7	11.0	9 0	13.0	15 5	14 5	20.0	20.7
Checks	2 0	4 0	3.8	0 0	0 0	0.6	1 0	1 0	0 6	1.4
Weather observations	(a)	....	(b)	....	(c)	....	....	....	....	....

[a] February 12. Shower for about half an hour. Day cloudy and cool.
[b] February 28. Shower for about two hours.
[c] March 19. Continuous shower from midnight, followed by heavy rain in the morning, then followed by continuous shower until midday.

After the third spraying (Tables 1 and 2) one hundred panicles on one sprayed section and another hundred on one control section of each tree were counted and the number of tip-borer-infested inflorescences recorded. The results of these counts are given in Table 3.

TABLE 3.—*Showing the number of tip-borer-infested panicles in every hundred counted on the control and sprayed parts of each tree.*

Trees in the first series (Table 1).			Trees in the second series (Table 2).		
Tree No.	Treated.	Controls.	Tree No.	Treated.	Controls.
1	5	11	9	0	4
2	0	2	10	5	13
3	3	5	11	4	4
4	5	4	12	4	6
5	2	8	13	4	2
6	7	10	14	1	0
		4	15	3	8
		5	16	5	6
			17	3	3
Average	3.7	6.1	Average	3.2	5.1

As the inflorescences developed they were examined from time to time for the occurrence of new hatchings of the hoppers and for anthracnose, while a number of both the inflorescences and fruits that developed from the control and sprayed sections of each tree were brought to the laboratory for further studies and isolation of the anthracnose organism.

Weather conditions at the time of spraying are recorded in Tables 1 and 2.

The comparative yield of the sprayed and control parts of each tree was determined when the fruits matured. This was done by placing at random a 3-square-meter circle, made of bamboo, over the sprayed and unsprayed parts of each tree, the fruits inclosed by the circle being counted. The fruits produced within the crown and which lay within the horizontal level of the circle were also counted. The results of these counts are given in Tables 1 and 2.

DISCUSSION OF THE SPRAYING EXPERIMENTS OF 1931

The use of lead arsenate in combination with Bordeaux mixture (Table 1) or with lime sulphur (Table 2) appears to be of little value as a control for the tip-borer pest on the panicles. The first two sprayings shown in Tables 1 and 2 were given during the period of rapid growth of the panicles and the failure of lead arsenate to control the tip-borer pest was perhaps due

to the fact that as the panicles elongated there were numerous points which were not covered by the spray, and the larvæ of the tip-borer pest might have entered through these unprotected parts. It is also doubtful whether or not the use of lead arsenate in the first and second sprayings (Tables 1 and 2) reduced materially the tip-borer injury, although on the average a reduction from 6.1 to 3.7 per cent is shown in Table 3 and from 5.1 to 3.2 per cent in Table 4. The results given in Tables 3 and 4 are uncertain because trees 4 and 7 in Table 3 and trees 13 and 14 in Table 4 showed a greater number of infested panicles on the sprayed than on the control portions. Furthermore, trees 11 and 17 in Table 4 showed an equal number of infested panicles on the sprayed and control parts. These results might even be accounted for by the unevenness of the distribution of the tip-borer pest in the tree.

The first two sprayings (Tables 1 and 2) were of no value in preventing the adult hoppers from laying eggs on the developing panicles. Egg punctures were noted on the flower stems and buds. The first brood of the hoppers occurred frequently before the opening of the flowers, since the spraying had no effect on the eggs. On some trees it occurred when the flowers were beginning to open. The second and third broods occurred generally during the blossoming period. The application of the second spray (Tables 1 and 2) was found to have killed the nymphs of the first brood except those which were not covered by the spray. It was observed that when the spray disturbed the panicles, the nymphs began to move downward to the twigs and those that were missed by the spray were found hiding beneath the leaves. This behavior of the nymphs necessitates a thorough application of the spray, not only to the inflorescences but also to the leaves and twigs. When the spray containing nicotine sulphate covered the soft bodies of the nymphs they were killed almost immediately. The third and fourth sprays (Tables 1 and 2) were found fairly efficient in killing the nymphs of the second and third broods. Nicotine-soap solution as the third and fourth sprays (Table 1) was also noted to be very effective in killing the nymphs.

Although the sprays containing nicotine sulphate in Tables 1 and 2 were effective in killing the nymphs of the hopper, they only partially reduced the damage done by this pest, since the adult hoppers weakened the tissues of the panicles by withdrawing a quantity of sap and making egg punctures in them,

and the spray not being applied until two to three days after the appearance of the new hatchings permitted the nymphs from the early-hatched eggs to feed on the inflorescences during this interval. Although the application of the spray seemed to be thorough, there were still some nymphs that were not covered by the spray. Likewise, when it rained hard, nymphs from the upper, unsprayed portions of the crown probably migrated and perhaps a few were washed down to the treated portions. This happened on the treated portions of trees 6, 7, and 8 in Table 1 and on trees 12, 13, 14, 15, 16, and 17 in Table 2. These trees were in blossom and their sprayed parts were almost free from hoppers before the heavy rain of March 19 occurred. Numerous nymphs of different stages were then noted on the sprayed sections after the rain had ceased. The treated parts were sprayed again March 20, at which time the nymphs had fed for about twenty-four hours. Despite the treatment that was given on this day the flowers were severely damaged, but the damage on the sprayed parts could not be attributed solely to the nymphs, since they fed on the inflorescences for only twenty-four hours. It was, therefore, presumed that the rain of March 19 might have had an injurious effect upon the fertilization of the complete flowers. Few fruits developed to maturity on the sprayed parts of the trees. The unsprayed portions were almost totally ruined. Likewise, the treated parts of trees 2 and 3 in Table 1 and trees 9 and 10 in Table 2 suffered great damage when the shower which continued for two hours February 23 occurred while they were in blossom. It may be noted in Tables 1 and 2 that the showers of February 12 and February 23 did not damage to any great extent the sprayed parts of trees 1, 4, and 5 in Table 1 and tree 11 in Table 2, owing perhaps to the fact that the rains occurred before these trees were in blossom. The sprayed portions of these trees produced a far greater number of fruits than those of other trees.

It is not certain whether the use of Bordeaux mixture (Table 1) and lime sulphur (Table 2) prevented anthracnose infection on the inflorescences. The sprayed portions of the trees in Tables 1 and 2 did not show the symptoms of anthracnose disease; but owing to the difficulty of diagnosing anthracnose disease on the hopper-infested inflorescences, it is not known whether or not the controls were attacked by this disease. Several attempts were made to isolate the anthracnose organism from the hopper-infested inflorescences, but the organisms that grew in the culture plates were mostly molds, *Acrothecium* and

Pestalozzia. However, the symptoms of anthracnose were noted on a number of young fruits as well as those up to 20 or 30 days old (Plate 4, figs. 3, 4, and 5). The infection was so light, however, that they were observed only on one tree. On the other trees the disease was not noted. Since anthracnose infection on inflorescences and fruits was not general in the orchard its absence on the sprayed parts of the trees under experiment was not strange.

Again it would be difficult to ascertain which of the two spray programs (Tables 1 and 2) gave the best results against the various agents concerned, because not all of the trees used in both series blossomed at the same time; consequently, the blossoms were not exposed to the same climatic influences. In Table 1 only three trees had their blossoms exposed to the bad weather of March 19, while in Table 2, six trees were exposed; thus, a lower average yield was obtained in Table 2 than in Table 1. Both procedures seem to be highly beneficial if no rains occur during the blossoming period to damage the inflorescence. The sprayed part of tree 1 (Plate 8, fig. 1) in Table 1 and tree 11 (Plate 8, fig. 2) in Table 2 produced a fairly good crop, owing perhaps to the fact that no rain occurred while the trees were in blossom. The unsprayed portions generally gave a poor harvest. Tree 11 (Plate 8, fig. 2) shows the development of a few fruits on its upper unsprayed portion. Comparing the average yield of the treated trees with the controls in Tables 1 and 2, it may be inferred that the increase in yield of the treated portions over the control portions is due to the beneficial effect of spraying.

COST OF SPRAYING

It was computed that the cost of spraying a tree with a crown of approximately 100 square meters,[5] following the program given in Table 1, would be 12.02 pesos—10.02 pesos for the sprays and 2 pesos for labor. Following the program in Table 2 it would cost 9.48 pesos to spray the same tree.

PROFIT THAT MIGHT BE REALIZED IN SPRAYING MANGO TREES OF THE CARABAO VARIETY UNDER THE CONDITIONS THAT EXISTED DURING THE COURSE OF THE INVESTIGATION

In Table 1, the average yield on 3-square-meter portions of the crown is 26.8 fruits for the treated and 3.4 fruits for the

[5] A tree with a crown of 100 square meters is not far from an average-sized tree in the orchard where this spraying investigation was conducted.

checks. Computing from these data, a sprayed tree with crown of 100 square meters would yield 893 fruits or 6 *kaings*.[a] If the same tree were not sprayed, it would yield 113 fruits, or less than 1 kaing. The price of carabao mangoes in the market varies according to the months in which they are harvested. Before the end of April a kaing of carabao mangoes costs 8 pesos or more. This price gradually falls until a kaing costs only 5 pesos at about the end of May and 2.50 to 4 pesos in June. Then it gradually rises again until the harvest period ends. Taking 5 pesos as an average price of one kaing of carabao mangoes, the profit that may be realized in spraying a tree with crown of 100 square meters may be computed as follows:

	Pesos.	Pesos.
Value of 6 kaings	30.00	....
Cost of spraying	....	12.02
Cost of smudging[a]	....	4.00
Cost of picking 6 kaings of mangoes[b]	....	0.48
Net returns	....	13.50
	30.00	30.00

[a] Smudging mango trees is done within an average of ten consecutive days. A laborer working at 80 centavos a day can smudge two trees within this period.
[b] A laborer working at 80 centavos a day can pick on the average 10 kaings.

Following the above computation the same tree if treated according to Table 2 would give net returns of 9.12 pesos. If the tree were unsprayed, there would be a net loss of approximately 32 centavos per tree according to the following computation:

	Pesos.	Pesos.
Value of 0.75 kaing (113 fruits)[a]	3.76	.....
Cost of smudging		4.00
Cost of picking	.....	0.08
Net loss	0.32	...
	4.08	4.08

[a] Computed from the average yield for all checks in Table 1.

The above data are in accord with the general observation of the people who saw the conditions of the orchard and with the statement of Mr. Ambrosio Reyes, overseer of Hacienda

[a] A "kaing" is a bamboo basket used for marketing mangoes. According to Mr. Ambrosio Reyes, overseer of Hacienda Madrigal at Muntinlupa, Rizal, a kaing contains on the average 150 fruits of the carabao variety. Director Stanton Youngberg, of the Philippine Bureau of Agriculture, states in his annual report for the year 1928 that a kaing contains approximately 124 fruits of the same variety.

Madrigal, that the trees of the carabao variety which were smudged, but not sprayed, this year (1931) at the hacienda did not give sufficient returns to cover the expenses for labor; only a number of trees of the pico variety which were smudged in the first half of February, gave a fairly good harvest.

A further proof that spraying is practicable may be mentioned. A trial was made in which the entire crown of a smudged carabao tree was sprayed according to Table 1. The tree was sprayed January 19, January 31, February 4, February 10, and February 14. Another smudged carabao tree of practically the same size and equal volume of inflorescence was used as control. The fruits were harvested in the latter part of April. The control tree yielded nearly 2 kaings and the sprayed tree more than 10 kaings. The price of mangoes at this time was 8 pesos a kaing. It cost 13.82 pesos to spray and 4 pesos to smudge the tree. Eighty centavos were spent for picking the mangoes from the sprayed tree and 16 centavos from the unsprayed one. A net profit of 61.38 pesos was thus realized from this single sprayed tree as against 11.84 pesos for the unsprayed, the difference of 49.50 pesos being clear gain.

SUMMARY

1. The great loss in the mango crop in the Philippines is due to a combination of several factors, among which the following are important: Abundance of the hopper pest, infestation of tip borers, severity of fruit shedding, outbreak of anthracnose, and occurrence of rains during the blossoming time.

2. The hopper pest has been noted to be the most important. In severe cases nearly all the inflorescences on a tree may be damaged. Two species of leaf hoppers on the inflorescence have been recognized. The large brown species, about 4.5 millimeters long, is *Idiocerus niveosparsus* Léthierry. A much smaller species, only about 3.5 millimeters long, ground color light greenish, is *I. clypealis* Léthierry. *Idiocerus clypealis* is more destructive than *I. niveosparsus* owing to its great abundance. The hoppers destroy the inflorescences by (*a*) making egg punctures on them, (*b*) drawing the sap from the tissues, and (*c*) excreting sticky, sweetish "honey dew" which favors the growth of sooty mold and prevents the fertilization of complete flowers to a certain extent. Two or more hatchings of the hoppers occur during the life of the inflorescence. The nymphal stage is the most destructive part in the life cycle.

3. Anthracnose is the most important fungous disease. High humidity increases the severity of attack. On the young leaves, it forms vinaceous brown or deep brownish vinaceous spots which may develop into large Mars brown or mummy brown blotches under humid conditions. It develops blackish brown spots on the flowers, fruits, and young shoots. It is also found commonly associated with insect injuries on the leaves. It is caused by the *Gloeosporium* stage of *Glomerella cingulata* (Stonem.) S. and v. S., which organism has also been found pathogenic on the young leaves and tender stems of mango seedlings.

4. Fruit shedding of mangoes is serious in Muntinlupa, Rizal Province. It is caused by various agencies but, since the majority of the shed fruits appear healthy, the trouble has been regarded as primarily physiological.

5. The tip-borer pest (*Chlumetia transversa* Walker) tunnels the panicles and young shoots of mango causing them to shrivel and dry.

6. In spraying experiments conducted at Muntinlupa, Rizal Province, on trees infested with hoppers and tip borers, and lightly attacked by anthracnose disease, spraying increased the yield of the treated trees from eight to fourteen times over the control. The first spraying consisted of: (*a*) A preliminary application of rather strong Bordeaux-lead arsenate given while the inflorescence buds were bursting. (*b*) A second spray of weaker Bordeaux mixture to which nicotine-sulphate and lead arsenate were added. (*c*) A third spray of nicotine-soap solution when a new brood of the hopper was noticed, and repeated at intervals of three to six days when further hatchings were observed. (*d*) Another spray of Bordeaux mixture-nicotine sulphate-lead arsenate when the petals were withering. The second set of tests consisted of: (*a*) A preliminary spray of lime sulphur 3° Beaumé to which lead arsenate was added, this being applied when the inflorescence buds were bursting. (*b*) A thorough spray of lime sulphur, 1.28° Beaumé, to which nicotine-sulphate and lead arsenate were added, applied on the appearance of the first brood of the hoppers, and repeated when further hatchings were noticed. (*c*) Another spray of lime sulphur-lead arsenate when the petals were withering.

The results obtained in the use of Bordeaux mixture and lime sulphur in both series did not prove conclusively that they can fully prevent the attack of anthracnose on the inflorescence. Likewise, it was also not certain that the number of tip borers

had been reduced by lead arsenate used in combination with the first and second sprays. The use of nicotine-sulphate in both series proved effective in reducing the damage by hoppers. Both preliminary spray series increased the yield from eight to fourteen fold and in the 1931 experiments led to a good net profit, whereas unsprayed trees handled at a loss.

Further experiments must be carried out, however, under less-favorable climatic conditions before safe generalizations can be made.

It is also very probable that the spray procedure can be considerably simplified and still yield good returns.

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ILLUSTRATIONS

PLATE 1

FIG. 1. *Idiocerus niveosparsus* Léthierry, adult stage; about × 2.
2. *Idiocerus clypealis* Léthierry, adult stage; about × 2.
3. *Idiocerus clypealis*, nymphs; about × 2.
4. A hopper-infested inflorescence showing the blighted flowers; about × 2/5.
5. A mango twig from a hopper-infested tree showing the growth of sooty mold on the leaves and peduncle that have been previously coated with the excrement ("honey dew") of the hoppers; about × 1/3.

PLATE 2

FIG. 1. A mango seedling taken from a bed of about one thousand seedlings, 60 per cent of which showed anthracnose disease. Note the numerous small, circular, vinaceous brown spots on the leaves and lower portion of the stem; about × 0.5.
2. A portion of a mango leaf collected in Solano, Nueva Vizcaya Province, showing the symptoms of anthracnose and also the mycelial growth of the causal fungus on the surface of the lesions. Beneath the growth are numerous, slimy, salmon buff masses of spores of the causal organism; about × 0.5.

PLATE 3

FIG. 1. Mango leaves blighted by anthracnose disease; about × 8/15.
2. A mango leaf showing large anthracnose blotches; about × 8/15.
3. Mango spikes showing a few flowers blighted by the anthracnose organism; natural size.
4. A portion of a mango leaf showing small galls caused by larvæ of the midge; nearly natural size.
5. A mango leaf showing spots and shot holes which have been primarily caused by the larvæ of the midge, with which the anthracnose organism may be associated; × 0.5.
6. Mango spikes whose flowers have dropped off owing to the attack of anthracnose. Note the anthracnose spots on them; × 2/3.

PLATE 4

FIG. 1. Stems of mango seedlings showing the early stage of anthracnose infection. Note small, circular, blackish brown spots on the stems; about × 2/3.
2. A case of a severe anthracnose disease on the stem of a young mango shoot. The leaves withered as a result of the attack; about × 2/3.

FIG. 3. Anthracnose on the young fruits and flowers of mango. Small masses of spores of the causal fungus have developed on one of the fruits; about × 2/3.

4. A 30-day-old mango fruit showing the early stage of anthracnose disease characterized by the development of small, circular, blackish brown spots; about × 2/3.

5. A 20-day-old mango fruit showing large blackish brown anthracnose spots upon which numerous small masses of spores of the causal fungus have developed; about × 2/3.

6. A ripening fruit of the carabao variety showing large, sunken, blackish brown blotches upon which may be noted the development of numerous masses of spores of the causal fungus; about × 2/3.

7. A mango twig bearing spotted and mummified young fruits, the cause of which is still unknown; about × 0.5.

PLATE 5

FIG. 1. A black stromatoid body from a 20-day-old potato-glucose-agar culture of the anthracnose organism isolated from mango flowers collected in Singalong, Manila; × 533.

2. A section through an acervulus that developed on the stem of a mango seedling inoculated with the anthracnose organism isolated from a mango leaf collected in Antipolo, Rizal Province; × 533.

3. A section through an acervulus from a 20-day-old potato-glucose-agar culture of the anthracnose organism isolated from mango flowers collected in Singalong, Manila. Note the development of fuscous black setæ; × 533.

4. Simple conidiophores shown as lateral outgrowths of the hyphæ. Obtained from a 1-month-old potato-glucose-agar culture of the anthracnose organism isolated from a mango stem collected in Cabagan, Isabela Province; × 533.

5. Spores from a 21-day-old potato-glucose-agar culture of the anthracnose organism isolated from the mango stem collected in Cabagan, Isabela Province; × 1200.

6. Conidiophores arising in groups from single hyphal cells. Obtained from 1-week-old culture of the anthracnose organism isolated from the mango stem collected in Cabagan, Isabela; × 1200. (All drawings in this plate were made with the aid of a camera lucida.)

PLATE 6

FIG. 1. A cracked fruit of the carabao variety. No organism is suspected of being responsible for the cracking; hence, it is regarded as a physiological trouble; × 2/3.

2. Mango shoots showing the infestation of tip borer. Note the shriveled and withered tips; × 1/3.

3. A leaf (right) from a mango seedling inoculated with the anthracnose organism isolated from mango flowers collected in Singalong, showing the symptoms of the disease; control leaf at the left; about × 2/3.

FIG. 4. Stems of mango seedlings inoculated with the anthracnose organism; *a*, inoculated with the organism from a mango leaf collected in Antipolo, Rizal Province; *b*, inoculated with the organism isolated from mango flowers collected in Singalong, Manila; *c*, inoculated with the organism isolated from a mango leaf collected in Muntinlupa, Rizal. All the inoculated seedlings showed numerous acervuli of the causal fungus on the stems; about × 2.

PLATE 7

FIG. 1. Showing a pico tree in blossom after the third weekly spraying with Bordeaux-nicotine-sulphate. The inflorescences which appeared healthy after the third spraying were severely damaged by the hoppers before the fourth weekly spraying was done; about × 1/60.

2. An inflorescence detached from the tree in fig. 1 showing no evident spray injury. Note the uniform coating of Bordeaux spray on the leaves; about × 1/3.

3. A hopper-infested inflorescence from a control tree showing growth of mold on the spikes and flowers. Note also that many of the flowers have dropped off; over × 1/3.

PLATE 8

FIG. 1. A carabao mango tree showing a fairly good yield after treating according to spray procedure given in Table 1 (see text). Note the fruits partially hidden under the leaves. The control part of the tree is not shown; about × 1/50.

2. A carabao mango tree treated according to the spray procedure in Table 2 (see text). Note the number of fruits that matured on the lower sprayed part of the crown. The upper, unsprayed portion shows relatively few fruits; about × 1/130.

PLATE 1.

PLATE 2.

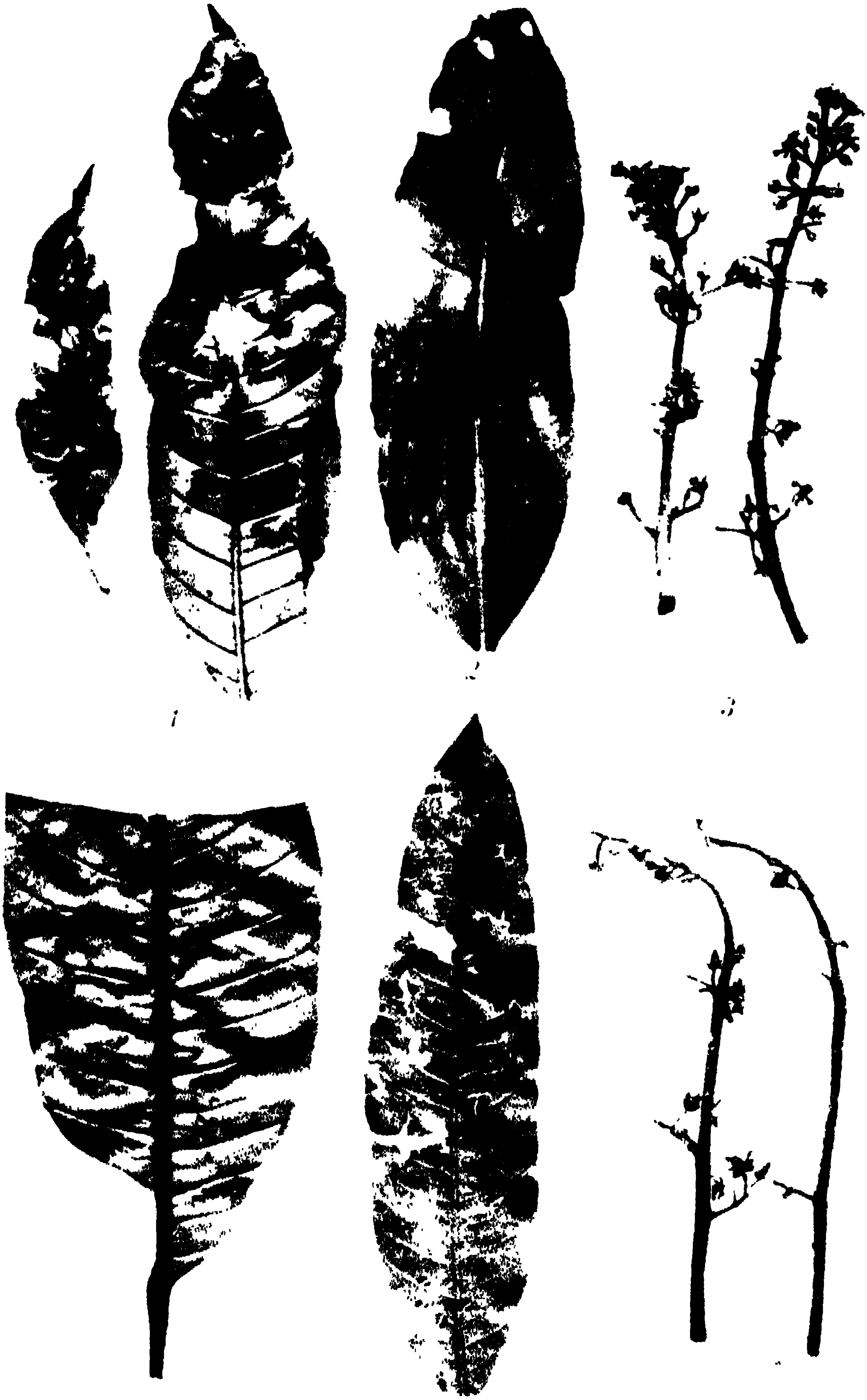

PLATE 3

PLATE 4

PLATE 5.

PLATE 6

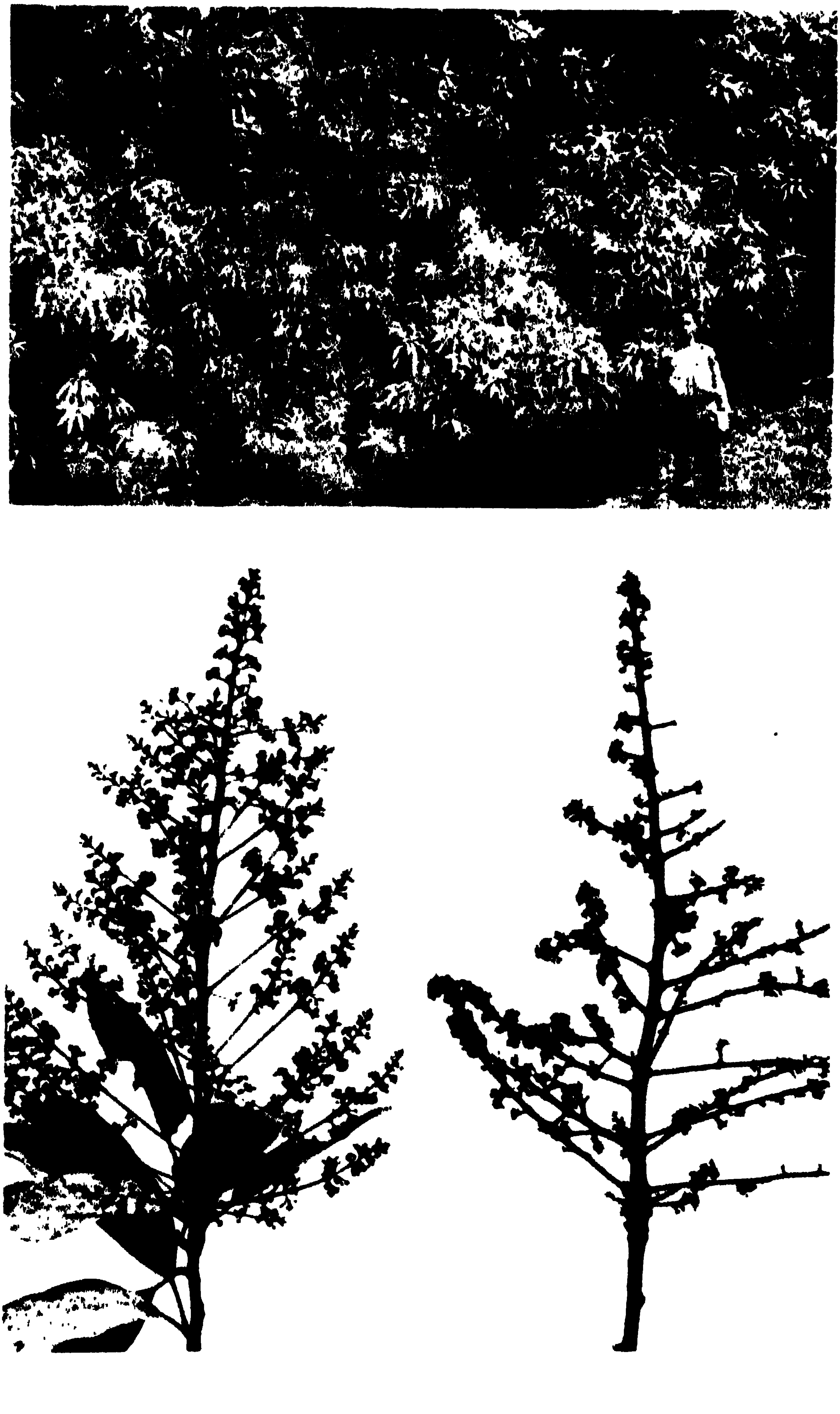

PLATE 7.

2

PLATE

THE INFLUENCE OF THE PERIOD OF AIR DRYING ON THE STRENGTH OF ABACÁ FIBER

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In the preparation of abacá fiber after its extraction from the leaf sheath it is the general practice to spread and allow it to dry for from eight to twelve hours or sometimes for very much longer periods, upon the apparent assumption that the period of drying is immaterial. As it was thought that this lack of uniformity in drying might result in a considerable variation in tensile strength of fibers from plants of the same variety growing in the same field or soil type, it was the aim of the present investigation to ascertain whether or not a difference in the drying period would make a difference in fiber strength and, incidentally, in fiber stretch.

The fibers of two of the commonest varieties of abacá found in Guinobatan, Albay Province, namely, the itom and puti tomatagakan, have been used in this study. These fibers came from flowering stalks grown in fields where the soils were of different types. They consisted of three separates from the outer, middle, and inner leaf sheaths, respectively. Each sample was divided into two portions, one of which was air-dried for ten hours and the other for twenty hours.

The method of determining tensile strength is described in detail in another paper.[1] The tensile strengths of fibers dried for 10- and 20-hour periods, respectively, together with their percentages of stretch and moisture contents are given in Table 1.

The tensile strength, according to the figures in columns 6, 9, and 12 of Table 1, seems to have been favorably affected by a longer period of air drying. Thus, column 6, which gives the average strength of not less than ten tests for each fiber separate from the outer leaf sheath, shows that in six cases out of eight the 20-hour dried portions were stronger by at least

[1] Philip. Journ. Sci. 48 (1932) 243.

TABLE 1.—*Moisture, amount of stretch, and tensile strength of abacá fibers from the outer, middle, and inner leaf sheaths.*

Variety.	Time dried.	Field.	Outer. Moisture (H_2O).	Outer. Average stretch in 20 cm.	Outer. Average tensile strength.	Middle. Moisture (H_2O).	Middle. Average stretch in 20 cm.	Middle. Average tensile strength.
	Hrs.		*P. ct.*	*P. ct.*	*Kg. per g.*	*P. ct.*	*P. ct.*	*Kg. per g.*
Itom	10	I	11.16	2.66	211.17	10.48	2.87	214.58
Do.	10	II	10.30	3.27	235.82	10.29	3.54	254.07
Do.	10	III	11.41	3.31	216.12	11.18	2.40	245.66
Do.	10	IV	11.22	2.71	227.90	11.44	2.93	234.70
Do.	20	I	10.82	2.94	255.21	10.27	2.78	257.75
Do.	20	II	10.24	2.74	234.88	10.84	3.06	245.38
Do.	20	III	11.02	2.79	255.17	10.85	3.04	251.76
Do.	20	IV	11.00	2	282.43	10.78	2.94	245.78
Puti tomatagakan	10	I	10.82	2.99	240.70	11.23	3.35	266.63
Do.	10	II	9.69	3.76	250.56	9.67	3.74	251.64
Do.	10	III	12.67	2.29	200.72	9.93	2.75	216.06
Do.	10	IV	10.90	3.14	222.83	11.15	2.90	214.09
Do.	20	I	10.41	3.21	262.77	10.47	2.92	277.57
Do.	20	II	10.37	3.27	247.70	10.19	3.04	268.68
Do.	20	III	10.96	2.86	264.02	10.08	3.18	243.75
Do.	20	IV	11.94	2.76	242.28	10.86	2.62	243.47

Variety.	Time dried.	Field.	Inner. Moisture (H_2O).	Inner. Average stretch in 20 cm.	Inner. Average tensile strength.	Tensile strength computed on the basis of moisture-free fiber. Outer.	Middle.	Inner.
	Hrs.		*P. ct.*	*P. ct.*	*Kg. per g.*	*Kg. per g.*	*Kg. per g.*	*Kg. per g.*
Itom	10	I	10.74	2.72	210.58	237.77	239.88	235.92
Do.	10	II	10.47	3.11	208.61	262.93	283.08	233.15
Do.	10	III	8.41	2.12	206.89	243.84	276.02	225.92
Do.	10	IV	12.21	2.64	192.56	255.91	265.02	219.16
Do.	20	I	10.54	2.59	211.28	285.96	287.24	236.02
Do.	20	II	10.20	2.74	221.68	261.49	273.54	246.60
Do.	20	III	10.11	2.77	229.40	286.53	280.77	254.89
Do.	20	IV	10.97	2.82	236.37	317.08	276.06	265.27
Do.	10	I	10.26	3.10	243.83	281.25	300.21	271.56
Puti tomatagakan	10	II	9.41	3.40	224.07	277.49	278.69	246.67
Do.	10	III	10.15	2.57	225.38	229.82	239.86	250.84
Do.	10	IV	10.90	2.98	231.93	250.19	240.83	259.80
Do.	20	I	9.15	2.77	206.45	293.82	309.45	227.11
Do.	20	II	10.00	2.72	213.87	276.26	299.11	237.23
Do.	20	III	11.21	2.66	221.60	296.48	271.01	249.51
Do.	20	IV	10.87	2.72	266.09	275.16	272.79	298.28

20 kilograms per gram than the 10-hour portions, and that in the other two cases the strength is practically the same for both portions if an allowance of ± 12 kilograms per gram be made, which allowance was actually found to be the maximum average variation in breaking strain for several sets of ten determinations performed for the same fiber portions. Columns 9 and 12, which correspond to the middle and inner leaf-sheath fibers, respectively, show similar increases, although in the case

TABLE 2.—*Gain or loss in tensile strength of abacá fiber incidental to its loss of moisture or to longer period of air drying.*

Variety.	Field.	Outer. Difference in moisture (H_2O) content between 10 and 20-hour dried fibers.	Outer. Observed loss or gain in strength incidental to longer period of drying.	Outer. Computed loss or gain in strength corresponding to change in moisture content.	Outer. Computed net loss or gain in strength.	Middle. Difference in moisture (H_2O) content between 10 and 20-hour dried fibers.	Middle. Observed loss or gain in strength incidental to longer period of drying.
		g.	*Kg. per g.*	*g.*	*Kg. per g.*	*g.*	*Kg. per g.*
Itom	I	0.0034	48.18+	0.81+	47.37+	0.0021−	47.36+
Do.	II	0.0006−	1.44−	0.16+	1.28−	0.0005+	9.49
Do.	III	0.0039−	42.69+	0.95+	41.74+	0.0078−	4.75+
Do.	IV	0.0022−	61.17+	0.56+	60.61+	0.0071+	20.11+
Puti tomatagakan	I	0.0041−	12.07+	1.15+	11.92+	0.0076−	9.24+
Do.	II	0.0068+	1.23+	1.89−	0.66+	0.0052+	20.42+
Do.	III	0.0071−	66.66+	1.63+	65.03+	0.0015+	31.15+
Do.	IV	0.0004+	24.97+	0.10−	25.07+	0.0029−	31.96+

Variety.	Field.	Middle. Computed loss or gain in strength corresponding to change in moisture content.	Middle. Computed net loss or gain in strength.	Inner. Difference in moisture (H_2O) content between 10 and 20-hour dried fibers.	Inner. Observed loss or gain in strength incidental to longer period of drying.	Inner. Computed loss or gain in strength corresponding to change in moisture content.	Inner. Computed net loss or gain in strength.
		g.	*Kg. per g.*	*g.*	*Kg. per g.*	*g.*	*Kg. per g.*
Itom	I	0.50+	46.86+	0.0020−	0.10+	0.47+	0.37−
Do.	II	0.14−	9.35−	0.0027−	13.45+	6.68+	12.82+
Do.	III	2.15+	2.60+	0.0070+	28.97+	1.58−	30.55+
Do.	IV	1.88+	18.23+	0.0124−	46.11+	2.72+	43.39+
Puti tomatagakan	I	2.28+	6.96+	0.0011−	44.45−	0.30+	44.75−
Do.	II	1.45	21.87+	0.0059+	9.44−	1.46−	7.98−
Do.	III	0.36−	31.51+	0.0106+	1.33	2.66−	1.33+
Do.	IV	0.70+	31.20+	0.0008−	38.48+	0.08+	38.40+

of the fibers from the inner section of the pseudostem of the puti variety the 20-hour dried portions have proved weaker than the 10-hour dried ones.

That the increase in strength noted for the 20-hour dried fibers could not be due to a decrease in moisture content and to a consequent increase in the weight or number of fiber strands that were subjected to stress seems to be demonstrated by the computed values in columns 13, 14, and 15 of Table 1, and particularly by the figures presented in Table 2, which were derived from the data contained in Table 1. The computed kilograms of force in columns 5, 9, 10, and 13 of Table 2 correspond to the differences in moisture content in grams (columns 3, 7, and 11) between the 10-hour and 20-hour dried fibers. If for these differences their equivalent weights of the fiber were substituted, variations would, as a rule, be extremely small or negligible as compared with the estimated net gains in strength per unit weight of the moisture-free fiber. For instance, in column 6 of Table 2 the net gains in strength vary from 11.92 to 65.03 kilograms per gram in six cases out of eight; in column 10, from 2.60 to 46.86 kilograms per gram in seven cases out of eight; and in column 14, from 1.33 to 43 kilograms per gram in five cases out of eight. If the maximum allowance for error of ±12 kilograms per gram were to be made, the result would be that out of twenty-four cases, fourteen would show computed net gains ranging from 0.8 to 54 kilograms per gram which may be attributed to longer drying; nine cases would show neither gain nor loss beyond the allowance for error, while in one case there was a loss. The increased strength incident to longer drying was most marked in the fibers from the outer section of the pseudostem, as these showed an average increase in strength of about 30 kilograms per gram; was less marked in the fibers from the middle part, which had an average increase in strength of 20 kilograms; and was still less marked or of doubtful significance in those from the inner part, where there was an average increase in strength of about 10 kilograms; three cases which came within the allowance of ± 12 kilograms, and the only case in which the fibers dried for twenty hours were weaker than those dried for ten hours by more than the allowance of ± 12 kilograms.

Adverting to the average percentages of stretch given in columns 5, 9, and 11 of Table 1, the results for the same fibers were so inconsistent as to convey the impression that the amount of stretch or elongation that the fibers could stand before break-

ing had not been influenced by the drying period or by the changes in moisture content which the fiber has undergone as a consequence of protracted air drying.

In connection with moisture change, it is of interest to note that from the figures in columns 4, 7, and 10 of Table 1, it appears that, under similar or the same weather conditions, fibers corresponding to the same leaf sheaths, air-dried for ten hours after their extraction, did not always seem to hold more moisture permanently than identical fibers dried for twenty hours, although ten additional hours of drying after the initial 10-hour period had in a great many cases caused a permanent moisture decrease in an amount seldom exceeding 1 per cent.

The foregoing results with regard to tensile strength afford an indication of the effect upon fiber strength of time length in air drying, and seem to suggest the advisability of taking this factor into account when determining the comparative strengths of abacá fibers.

Determination of the effect of sun drying on the strength of these fibers might prove an investigation of practical interest.

THE VARIABILITY OF TENSILE STRENGTH OF COMMERCIAL ABACÁ FIBERS OF THE SAME ORIGIN IN THE PSEUDOSTEM

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It has been observed that abacá fibers of the same origin in the pseudostem, dried for the same length of time, when tested for tensile strength by the use of a Louis Schöpper testing machine, according to the method described below, broke under diverse amounts of applied force which were out of all proportion to the differences in the quantity, by weight, of the fiber subjected to stress. The purpose of the present report is to invite attention to this fact and to show how the values for individual tests, expressed in kilograms of force per gram of the fiber, deviate from the mean of such values.

METHOD OF DETERMINING THE TENSILE STRENGTH OF ABACÁ

A portion of the fiber, nearly 40 centimeters long, which corresponds to the base or lower part of the leaf sheath is cut off the hank. Enough of the strands so cut are taken at random and arranged in such a way that the base end of a half of their number coincides with the opposite end of the other half. The extremities are then trimmed off by almost equal lengths so that a portion only about 27 centimeters long is left. This portion is clamped on a 50-kilogram Louis Schöpper testing machine. Both extremities of the portion are prevented from coming in direct contact with the metal clamps by wrapping them with blotting paper. Before the lower extremity is clamped on the machine the strands are properly arranged and straightened by a light pull, and are finally twisted so that all of them can, as much as possible, be subjected equally to stress. The speed of the shaft is 150 millimeters per minute. Upon completion of the test, the broken strands are clipped off as close as possible to the clamps and are made into a ball by squeezing and rolling them together between the dry thumb and forefinger. This ball is finally weighed in an analytical balance. In this

manner the actual tensile strength of a definite weight of the fiber sample is ascertained. Also, since the distance between clamps is 20 centimeters, a 40-centimeter portion of each strand is actually subjected to stress. For the capacity of the machine and with the ordinary abacá fiber, the actual weight of the fiber that can be tested at a time does not exceed 17 centigrams. For the sake of convenience and in order to acquire a clear idea of relative strengths the reading in kilograms corresponding to a definite weight or fraction of a gram is calculated to a common basis; namely, to kilograms per gram weight of the fiber.

In the following table are presented the data from a great number of tensile-strength tests of fibers taken from the five outer, five middle, and five or six inner leaf sheaths of the pseudostem of two varieties of abacá commonly grown in Guinobatan, Albay.

It is apparent from these tables that the breaking strains of equal quantities of fibers of the same origin in the same pseudostem vary through rather wide limits, and that the deviation of the value for any single test from that of the mean for a number of tests is considerable.

Regardless of variety this deviation is different for any set of tests, and for fibers from the outer and middle leaf sheaths its range is great, being 11.7 to 33.7 kilograms per gram in the present case. For fibers from the inner leaf sheaths this range seems to be still greater. It would seem, therefore, that great care should be exercised in judging the tensile strength of abacá, especially if only a few tests have been made.

TABLE 1.—*Tensile strength of dried fibers from various leaf sheaths of the pseudostem of two kinds of abacá.*

TENSILE STRENGTH OF 10-HOUR DRIED FIBERS FROM THE FIVE OUTER LEAF SHEATHS OF THE PSEUDOSTEM OF ITOM.

Trial No.—	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.
	FIELD I, FIBER GRADE S_2.				FIELD II, FIBER GRADE S_2.				FIELD III, FIBER GRADE S_2.				FIELD IV, FIBER GRADE S_1.			
	g.	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*
1	0 1470	29 10	198 0	2 80	0 1455	26 10	179.4	3 00	0 1450	36.65	252.7	3.20	0 1440	32.30	224 3	3.00
2	0 1480	31 00	209.5	2 80	0 1440	35 00	243 0	3 40	0.1555	32 60	209 6	3 30	0.1460	37.80	258 9	2 80
3	0 1480	34 60	233 8	3 00	0 1400	30 00	214 3	3.00	0.1455	34.05	234 0	3 40	0.1430	28 90	202.1	2 40
4	0 1410	32 70	231 9	2 80	0 1440	36 50	253.5	3 00	0 1490	32 00	214 7	3.40	0 1405	34 00	242 0	3 00
5	0 1410	30 80	218 4	2 40	0 1465	31 50	215 0	3 40	0 1535	34.60	225 0	3.70	0.1430	32.30	225 9	3.00
6	0 1470	32 70	222 4	2 60	0 1465	33 50	228 7	3.40	0.1520	23 85	189 8	3 00	0.1415	31.90	225 4	2.40
7	0.1420	25 90	182 4	2 40	0 1455	36 40	250 3	3 40	0.1490	29 90	200 6	3 50	0.1435	34.70	241.8	2 60
8	0 1430	30 20	211 2	2 60	0 1455	40 50	278 4	3 00	0.1505	37 45	248 8	3.33	0 1480	34 60	233 8	3 00
9	0 1440	33 10	229 9	2 60	0 1420	33 80	238 1	3 40	0.1570	32.50	207 0	3 20	0.1430	30.40	212 6	2.40
10	0 1440	31 80	220 8	2 60	0 1420	30.00	211 3	3 00	0 1465	26.30	179 0	3 10	0 1450	29 20	201.4	2.30
11	0 1435	26 60	185 4	2 60	0 1440	36 00	250 0	3 60					0 1510	32.70	216.6	2.80
12	0.1450	27 60	190 3	2 80	0 1480	42 50	287 2	3 40					0.1435	36.00	250.9	2 40
13					0 1440	34 50	239 6	3 40								
14					0 1455	30 80	211 7	3.40								
Mean			211 17	2 66			235 82	3 27			216 12	3 31			227 90	2 71
Standard deviation of single tests from the mean			±17 5				±27.5				±22.9				±17.5	

TABLE 1.—*Tensile strength of dried fibers from various leaf sheaths of the pseudostem of two kinds of abacá*—Continued.

TENSILE STRENGTH OF 10-HOUR DRIED FIBERS FROM THE FIVE OUTER LEAF SHEATHS OF THE PSEUDOSTEM OF PUTI TOMATAGAKAN.

Trial No.—	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Saretch in 20 cm.
	FIELD I, FIBER GRADE S_1 AND S_2.				FIELD II, FIBER GRADE F.				FIELD III, FIBER GRADE S_2.				FIELD IV, FIBER GRADE S_2.			
	g.	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*
1	0.1380	34.00	246.4	2.80	0.1510	43.40	287.4	3.80	0.1450	27.60	190.3	1.90	0.1460	33.50	229.6	3.00
2	0.1395	32.50	233.0	3.40	0.1465	33.90	231.4	3.60	0.1450	27.60	190.3	1.90	0.1500	34.50	230.0	3.20
3	0.1425	37.60	263.9	3.20	0.1485	43.40	292.5	4.20	0.1460	26.50	181.5	2.00	0.1500	29.00	193.3	3.20
4	0.1415	30.60	216.3	2.80	0.1510	38.50	255.0	3.80	0.1375	32.20	234.1	1.90	0.1410	30.40	215.6	3.60
5	0.1440	31.00	215.3	3.00	0.1510	41.10	272.2	3.40	0.1490	31.10	208.7	2.00	0.1400	25.00	178.6	3.00
6	0.1440	38.50	267.4	3.00	0.1535	40.50	263.8	3.40	0.1470	29.00	197.3	2.20	0.1390	34.30	246.9	3.00
7	0.1435	37.10	258.5	2.80	0.1470	31.60	215.0	4.20	0.1400	28.30	202.0	2.00	0.1480	37.60	254.1	2.90
8	0.1405	31.00	220.6	2.80	0.1500	36.80	245.3	4.20	0.1400	27.40	195.7	2.40	0.1360	30.30	222.8	3.50
9	0.1445	37.00	256.1	3.00	0.1465	32.10	220.0	3.80	0.1400	26.60	190.0	2.20	0.1460	35.50	243.2	3.00
10	0.1410	36.60	259.6	3.00	0.1480	41.30	279.0	3.60	0.1420	31.00	217.3	2.00	0.1410	30.20	214.2	3.00
11	0.1445	40.20	278.1	3.00	0.1475	36.90	251.0	3.80								
12	0.1425	29.00	203.5	2.80	0.1485	29.90	201.3	3.60								
13	0.1430	32.00	223.8	2.80	0.1510	39.10	258.9	3.40								
14	0.1425	31.90	223.9	3.00	0.1450	31.30	215.9	3.80								
15	0.1480	38.60	260.8	3.00	0.1490	40.10	270.0	3.80								
16	0.1435	32.20	224.8	3.40												
Mean			240.70	2.99			250.56	3.76			200.72	2.29			222.83	3.14
Standard deviation of single tests from the mean			±22.5				±27.4				±1. 8				±22.4	

TENSILE STRENGTH OF 20-HOUR DRIED FIBERS FROM THE FIVE OUTER LEAF SHEATHS OF THE PSEUDOSTEM OF ITOM.

	Field I, fiber grade S_2.				Field II, fiber grade S_1.				Field III, fiber grade S_2.				Field IV, fiber grade S_2.			
1	0.1415	34 80	245.9	2 80	0 1455	26 80	184.2	2 60	0.1480	36 60	247.4	2 80	0 1450	44.60	307.6	3.20
2	0 1440	33 00	229.2	2 80	0 1430	35 00	244 8	2 80	0 1440	37 30	259 0	3 00	0.1480	41.60	282.0	3.20
3	0.1415	36 80	260.7	2 80	0 1430	36.30	253 1	3 40	0 1430	32 10	224 5	2.30	0 1160	38.20	261.6	3.00
4	0 1465	32 10	219 1	2 80	0 1465	27 80	189 8	2 60	0 1450	38 50	265 5	2 90	0 1450	39.10	269.7	2 80
5	0.1415	36.30	256 5	3 00	0 1465	30 40	207 5	2 60	0 1365	37 60	275 5	3 00	0 1425	41.50	291.0	3.00
6	0 1460	36.60	250.7	3.00	0 1430	38 10	266 4	3 20	0.1492	36 50	245 6	2 80	0 1460	37 60	257.5	2.60
7	0.1400	38.80	277 1	3 00	0 1433	38 20	266 6	3 20	0 1195	40 20	268 9	2 80	0.1470	42.50	290.0	2.80
8	0 1400	34 80	248 6	3 00	0 1435	35 20	245 8	2 80	0 1490	36 40	244 6	2 80	0 1385	38.40	277.3	2.60
9	0.1420	39.80	280 3	3 00	0 1415	31 90	225 4	3 00	0 1460	36 80	252 1	2 80	0 1470	41.60	283 0	2.60
10	0 1440	40 90	284 0	3 20	0 1415	37 60	265 7	3 20	0 1400	37 50	267 9	2 80	0.1415	43.10	304.6	3.00
Mean			255 21	2.94			234.88	2 74			255 17	2.79			282.48	2.98
Standard deviation of single tests from the mean			±20 2				±29 9				±17.6				±15.8	

TABLE 1.—*Tensile strength of dried fibers from various leaf sheaths of the pseudostem of two kinds of abacá*—Continued.

TENSILE STRENGTH OF 26-HOUR DRIED FIBERS FROM THE FIVE OUTER LEAF SHEATHS OF THE PSEUDOSTEM OF PUTI TOMATAGAKAN.

Trial No.—	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.
	FIELD I, FIBER GRADE S_1 AND S_2.				FIELD II, FIBER GRADE F.				FIELD III, FIBER GRADE S_2.				FIELD IV, FIBER GRADE S_1.			
	g.	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*
1	0.1410	28.50	202.1	2.80	0.1395	38.10	273.1	3.20	0.1510	31.80	210.6	3.00	0.1410	32.30	230.0	2.80
2	0.1440	35.60	247.2	3.40	0.1470	35.20	239.5	3.20	0.1490	40.90	274.5	3.00	0.1470	35.20	239.5	3.00
3	0.1430	41.60	290.9	3.20	0.1440	34.30	238.2	3.21	0.1550	36.60	236.0	2.80	0.1470	41.00	278.9	2.80
4	0.1410	42.60	302.1	3.20	0.1445	36.60	253.3	3.40	0.1485	40.40	272.0	2.80	0.1475	40.60	275.3	3.00
5	0.1445	37.30	258.1	3.00	0.1465	37.40	255.3	3.50	0.1500	37.60	250.7	2.80	0.1470	37.80	258.0	3.00
6	0.1420	38.60	271.8	3.60	0.1405	35.00	249.1	3.50	0.1460	45.70	313.0	3.00	0.1475	33.30	225.8	2.60
7	0.1445	41.00	283.7	3.50	0.1430	36.50	255.2	3.20	0.1490	39.10	262.4	2.80	0.1440	36.00	250.0	2.80
8	0.1420	28.00	197.2	3.00	0.1430	34.60	242.0	3.20	0.1480	39.40	264.4	3.00	0.1465	32.30	220.0	2.60
9	0.1410	44.30	314.2	3.60	0.1450	36.20	249.7	3.30	0.1456	40.20	274.0	2.60	0.1450	29.80	205.5	2.40
10	0.1440	37.50	260.4	2.80	0.1435	31.80	221.6	3.20	0.1550	43.50	280.6	2.80	0.1375	31.60	229.8	2.60
Mean			262.77	3.21			247.70	3.27			264.02	2.86			241.28	2.76
Standard deviation of single tests from the mean			±38.7				±12.9				±26.0				±21.9	

TENSILE STRENGTH OF 16-HOUR DRIED FIBERS FROM THE FIVE MIDDLE LEAF SHEATHS OF THE PSEUDOSTEM OF ITOM.

	FIELD I, FIBER GRADE E.				FIELD II, FIBER GRADE D.				FIELD III, FIBER GRADE E				FIELD IV, FIBER GRADE D AND E.			
1	0.1440	28 40	197 2	2 60	0.1400	28.00	200 0	3 00	0.1410	37 30	264.5	2.40	0.1390	27.10	195.0	2.40
2	0 1440	26 20	181 9	2 60	0.1435	40 00	278.7	3 40	0 1400	41.40	295 7	2.60	0.1470	36.80	250.3	3.00
3	0 1410	34.10	241.8	3.00	0 1470	31.00	210.9	3.00	0 1475	33 60	227 8	3.00	0.1450	39.40	271.7	3.00
4	0 1455	33.50	230 2	3.00	0 1440	33 00	229 2	4 00	0.1475	40 40	273.9	2.40	0.1430	29.00	282.8	3.00
5	0.1480	31.80	214 9	2.80	0.1445	32.00	221.5	3 60	0 1450	32 60	224 8	2 30	0.1505	31.20	267.3	2.60
6	0.1420	35.20	247.8	2 80	0.1420	36.50	257.0	3 80	0 1460	36 15	247 2	2.80	0.1490	35.80	240.3	2.80
7	0 1440	35 00	243.0	3.00	0.1480	30.40	205.4	3 80	0.1470	32.45	220.4	2.20	0.1460	38.90	266.4	3.00
8	0 1460	29 50	202.0	3.00	0.1450	37 20	256.5	3.40	0.1490	39.00	261.7	3 40	0.1445	30.80	213.1	3.00
9	0 1440	28 70	199.3	2.80	0.1470	38.10	259.2	3.60	0.1450	35.30	243.4	2.40	0.1380	36.70	265.9	3.00
10	0 1470	33.50	227 9	3.40	0 1450	45 20	312.7	3.60	0.1490	33.60	225.5	2.20	0.1470	33.00	224.5	3.00
11	0 1435	29.10	202.8	2.80	0.1425	39 60	277 9	3.40	0.1510	40.15	265.9	2.40	0.1480	34.80	235.1	3.00
12	0 1370	25 50	186 1	2.60	0 1440	43.10	299.3	4 00	0.1455	37 45	257.4	2.30	0.1420	32.10	226.0	2.80
13					0.1415	34.40	243 1	3.60	0.1455	37.00	254 3	2.50	0.1400	33.50	239.3	3.20
14					0.1420	48.40	305.6	3 20	0.1465	34.30	234.1	2.00	0.1410	35.00	248.2	3.40
15									0.1450	39.00	269 0	2.20				
16									0.1410	33.20	235 5	2.20				
17									0.1450	33.05	227.9	2.20				
18									0.1495	32.00	214.7	2.20				
19									0.1510	35.80	237.1	2.20				
20									0.1510	35.10	232.5	2 20				
Mean			214.58	2 87			254.07	3 54			245.66	2.40			234.70	2.98
Standard deviation of single tests from the mean			±23.0				±34.4				±21.8				±23.6	

TABLE 1.—*Tensile strength of dried fibers from various leaf sheaths of the pseudostem of two kinds of abacá*—Continued.

TENSILE STRENGTH OF 10-HOUR DRIED FIBERS FROM THE FIVE MIDDLE LEAF SHEATHS OF THE PSEUDOSTEM OF PUTI TOMATAGAKAN.

Trial No.—	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.
	FIELD I, FIBER GRADE D AND E.				FIELD II, FIBER GRADE E.				FIELD III, FIBER GRADE E.				FIELD IV, FIBER GRADE E.			
	g.	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*
1	0.1430	38.00	265.7	3.40	0.1400	40.50	289.4	4.00	0.1465	27.20	185.7	2.40	0.1510	35.00	231.9	3.00
2	0.1425	36.70	257.5	2.80	0.1450	38.80	267.6	4.00	0.1480	31.80	214.8	2.60	0.1445	34.90	241.6	3.00
3	0.1395	44.80	321.2	3.40	0.1450	39.90	275.2	4.20	0.1430	27.00	188.8	2.40	0.1420	25.40	178.9	2.60
4	0.1450	41.20	284.1	3.00	0.1465	38.20	260.8	3.60	0.1405	27.50	195.7	2.60	0.1465	26.50	180.9	2.60
5	0.1420	39.70	279.5	3.60	0.1470	36.40	247.6	3.80	0.1400	31.50	225.0	2.40	0.1390	35.00	251.8	3.00
6	0.1475	35.80	242.7	3.00	0.1430	30.00	209.8	3.40	0.1470	37.20	253.1	3.00	0.1440	29.80	206.9	3.00
7	0.1415	34.70	245.2	4.00	0.1450	37.60	259.3	3.40	0.1395	28.00	200.7	3.00	0.1490	32.00	214.8	2.80
8	0.1470	37.00	251.7	3.00	0.1390	33.10	238.1	3.80	0.1450	36.00	248.3	3.00	0.1440	35.10	243.8	3.00
9	0.1450	35.10	242.0	3.60	0.1430	35.40	247.6	3.40	0.1470	32.90	223.8	2.40	0.1460	30.00	205.5	2.80
10	0.1440	43.00	298.6	3.60	0.1460	34.80	238.4	3.80	0.1470	35.20	239.5	3.40	0.1420	30.40	214.1	3.00
11	0.1440	40.00	277.8	3.60	0.1430	35.20	246.1	3.80	0.1440	32.50	225.7	3.40	0.1440	29.80	206.9	2.80
12	0.1475	38.00	257.6	3.40	0.1450	35.80	246.9	3.40	0.1485	28.20	189.9	2.40	0.1490	28.20	189.3	3.00
13	0.1440	38.70	268.8	3.40	0.1450	34.80	240.0	3.60					0.1390	32.00	230.2	3.00
14	0.1440	35.70	247.9	3.00	0.1430	38.40	268.5	4.00					0.1420	28.50	200.7	3.00
15	0.1470	38.10	259.2	3.40	0.1455	38.80	266.7	3.80								
16					0.1405	31.50	224.2	3.80								
Mean			266.63	3.35			251.64	3.74			216.06	2.75			214.09	2.90
Standard deviation of single tests from the mean			±22.2				±19.3				±22.7				±22.3	

TENSILE STRENGTH OF 20-HOUR DRIED FIBERS FROM THE FIVE MIDDLE LEAF SHEATHS OF THE PSEUDOSTEM OF ITOM.

	Field I, fiber grade E.				Field II, fiber grade D.				Field III, fiber grade E.				Field IV, fiber grade D and E.			
1	0.1440	40.00	277.8	2.80	0.1430	29.80	208.4	3.20	0.1450	35.00	241.4	3.20	0.1480	32.50	219.6	3.00
2	0.1370	32.10	234.3	2.60	0.1427	33.40	234.0	3.20	0.1435	35.20	245.3	3.00	0.1485	30.20	203.4	2.60
3	0.1420	43.60	307.0	2.80	0.1385	36.00	260.4	3.20	0.1475	36.80	249.5	2.80	0.1425	40.50	284.2	3.40
4	0.1440	40.60	281.9	3.00	0.1430	37.10	259.4	3.20	0.1450	33.10	228.3	3.00	0.1450	35.60	245.5	2.80
5	0.1470	37.10	252.4	3.00	0.1440	34.60	240.2	2.80	0.1435	36.00	250.9	3.00	0.1455	37.80	259.8	3.20
6	0.1455	34.60	237.8	2.80	0.1420	32.90	231.7	2.80	0.1450	31.20	215.2	3.20	0.1455	34.20	235.1	2.60
7	0.1480	36.10	243.9	2.80	0.1420	33.40	235.2	3.00	0.1440	38.10	264.6	3.00	0.1435	40.90	284.9	3.20
8	0.1450	37.30	257.2	2.80	0.1450	40.00	275.9	3.40	0.1480	39.60	267.6	3.00	0.1445	30.60	211.8	2.60
9	0.1425	34.50	242.1	2.60	0.1425	40.80	286.3	3.20	0.1420	39.80	280.3	3.00	0.1455	39.80	273.5	3.20
10	0.1440	35.00	243.1	2.60	0.1480	32.90	222.3	2.60	0.1450	39.80	274.5	3.20	0.1450	34.80	240.0	2.80
Mean			257.75	2.78			245.38	3.06			251.76	3.04			245.78	2.94
Standard deviation of single tests from the mean			±22.4				±23.2				±19.5				±27.8	

TABLE 1.—*Tensile strength of dried fibers from various leaf sheaths of the pseudostem of two kinds of abacá*—Continued.

TENSILE STRENGTH OF 20-HOUR DRIED FIBERS FROM THE FIVE MIDDLE LEAF SHEATHS OF THE PSEUDOSTEM OF PUTI TOMATAGAKAN.

Trial No.—	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.
	FIELD I, FIBER GRADE D AND E.				FIELD II, FIBER GRADE E.				FIELD III, FIBER GRADE E.				FIELD IV, FIBER GRADE E.			
	g.	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*
1	0.1440	37.50	260.4	3.00	0.1445	39.90	276.1	3.40	0.1480	39.70	268.2	3.20	0.1440	25.00	173.6	2.20
2	0.1425	42.10	295.4	3.40	0.1445	39.60	274.0	3.40	0.1515	35.30	233.0	3.20	0.1425	31.60	222.5	2.40
3	0.1490	38.80	260.4	3.00	0.1445	39.20	271.3	2.90	0.1473	37.50	254.6	3.40	0.1387	40.60	292.7	3.20
4	0.1455	42.00	288.7	3.00	0.1415	38.90	274.9	3.00	0.1520	37.50	246.7	3.60	0.1460	36.00	246.6	2.80
5	0.1420	44.40	312.6	3.20	0.1400	35.50	253.6	3.00	0.1450	34.00	234.5	3.00	0.1425	36.60	256.8	2.40
6	0.1430	42.70	298.6	3.00	0.1375	34.80	253.1	2.80	0.1535	39.50	257.3	3.20	0.1425	40.90	287.0	2.80
7	0.1480	42.80	289.1	3.00	0.1395	39.80	285.3	3.20	0.1510	34.40	227.8	3.20	0.1430	37.40	261.5	2.60
8	0.1430	35.80	250.3	2.60	0.1345	38.20	284.0	3.20	0.1530	37.90	247.7	3.00	0.1440	31.30	217.4	2.60
9	0.1465	38.20	260.8	3.00	0.1448	37.30	257.6	3.20	0.1530	33.20	217.0	3.00	0.1440	37.40	259.7	2.60
10	0.1430	37.10	259.4	3.00	0.1440	37.00	256.9	3.00	0.1480	37.10	250.7	3.00	0.1420	31.30	220.4	2.40
11													0.1380	33.00	240.0	2.80
Mean			277.57	2.92			268.68	3.04			243.75	3.18			243.47	2.62
Standard deviation of single tests from the mean			±20.4				±11.7				±14.7				±32.5	

TENSILE STRENGTH OF 10-HOUR DRIED FIBERS FROM FIVE OR SIX INNER LEAF SHEATHS OF THE PSEUDOSTEM OF ITOM.

	Field I, fiber grade E.				Field II, fiber grade C.				Field III, fiber grade C.				Field IV, fiber grade D.			
1	0.1425	32.50	228.1	2.40	0.1460	24.80	169.9	3.00	0.1400	27.00	192.9	2.00	0.1490	29.70	199.3	2.60
2	0.1410	30.30	214.9	3.00	0.1475	34.80	235.9	3.20	0.1420	30.20	212.7	2.00	0.1470	26.10	177.6	2.40
3	0.1410	30.20	214.2	2.80	0.1435	34.10	237.6	3.20	0.1380	31.80	230.4	2.10	0.1460	31.50	215.8	3.00
4	0.1450	30.80	212.4	3.00	0.1445	29.40	203.5	3.00	0.1410	24.40	173.0	2.00	0.1440	27.20	188.9	2.80
5	0.1400	26.00	190.0	2.80	0.1490	30.30	203.4	3.00	0.1450	32.40	223.4	2.20	0.1490	23.80	159.7	2.60
6	0.1425	26.20	183.8	2.60	0.1425	34.40	241.4	3.20	0.1455	34.80	239.1	2.30	0.1455	26.80	184.2	2.40
7	0.1425	32.00	224.6	2.80	0.1520	38.20	251.3	3.80	0.1480	28.90	195.3	2.30	0.1480	26.60	179.7	2.40
8	0.1420	24.70	173.9	2.40	0.1460	24.80	164.2	3.00	0.1435	30.70	213.9	2.00	0.1400	29.80	212.9	2.60
9	0.1440	34.20	237.5	2.80	0.1480	27.40	185.0	3.20	0.1445	24.40	169.0	1.90	0.1470	30.00	204.1	2.80
10	0.1440	30.50	211.8	2.80	0.1450	30.40	209.7	3.20	0.1455	31.50	215.5	2.20	0.1460	29.70	203.4	2.80
11	0.1385	33.30	240.4	2.60	0.1434	31.80	221.8	3.20								
12	0.1410	32.00	227.0	2.80	0.1480	26.60	179.7	3.40								
13	0.1445	27.00	186.9	2.60												
14	0.1425	27.00	189.5	2.80												
15	0.1455	32.50	223.4	2.60												
Mean			210.56	2.72			206.61	3.11			206.89	2.12			192.56	2.64
Standard deviation of single tests from the mean			±6.4				±28.2				±22.2				±16.7	

TABLE 1.—*Tensile strength of dried fibers from various leaf sheaths of the pseudostem of two kinds of abacá*—Continued.

TENSILE STRENGTH OF 10-HOUR DRIED FIBERS FROM FIVE OR SIX INNER LEAF SHEATHS OF THE PSEUDOSTEM OF PUTI TOMATAGAKAN.

Trial No.—	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.
	FIELD I, FIBER GRADE D AND E.				FIELD II, FIBER GRADE D.				FIELD III, FIBER GRADE E.				FIELD IV, FIBER GRADE D.			
	g.	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*
1	0.1460	35.50	243.2	3.80	0.1510	32.90	217.9	3.40	0.1400	30.20	215.7	3.40	0.1470	33.40	227.2	3.00
2	0.1460	34.50	236.3	3.40	0.1545	32.50	210.4	3.40	0.1355	31.50	232.5	2.30	0.1455	41.50	285.2	3.00
3	0.1450	35.00	241.4	3.00	0.1485	36.70	247.1	3.60	0.1410	28.00	198.5	2.40	0.1440	34.40	238.9	3.00
4	0.1450	32.50	218.1	2.80	0.1520	33.30	219.1	3.60	0.1410	32.50	230.5	2.50	0.1455	27.00	185.6	3.00
5	0.1440	41.50	288.2	3.00	0.1430	34.00	237.8	3.60	0.1480	29.10	196.6	2.40	0.1470	29.00	197.3	3.00
6	0.1450	38.90	268.3	3.00	0.1510	33.30	220.5	3.20	0.1385	37.30	269.3	2.70	0.1450	31.50	217.2	3.20
7	0.1450	30.50	210.3	2.80	0.1685	37.20	220.8	3.60	0.1450	30.40	209.7	2.90	0.1455	31.60	217.2	3.20
8	0.1460	37.00	253.4	2.80	0.1740	28.70	164.9	2.40	0.1460	31.80	217.8	2.30	0.1435	42.00	292.6	3.20
9	0.1470	30.20	205.4	2.40	0.1535	35.80	233.2	3.40	0.1460	33.30	228.0	2.60	0.1435	37.50	261.3	3.00
10	0.1450	40.00	275.9	3.20	0.1695	39.10	230.7	3.60	0.1480	37.70	254.7	2.40	0.1450	27.50	189.6	2.60
11	0.1430	30.90	216.1	3.00	0.1475	34.60	234.5	3.60	0.1440	34.20	237.5	2.40	0.1490	33.10	222.2	2.60
12	0.1420	38.30	269.7	3.00	0.1625	37.70	232.0	3.40	0.1410	30.30	214.8	2.60	0.1430	35.60	248.9	3.00
13					0.1490	34.90	234.2	3.40								
14					0.1420	33.30	234.5	3.40								
Mean			243.83	3.01			224.07	3.40			225.38	2.57			231.93	2.98
Standard deviation of single tests from the mean			±26.8				±18.9				±21.0				±33.4	

TENSILE STRENGTH OF 20-HOUR DRIED FIBERS FROM FIVE OR SIX INNER LEAF SHEATHS OF THE PSEUDOSTEM OF ITOM.

	FIELD I, FIBER GRADE E.				FIELD II, FIBER GRADE C.				FIELD III, FIBER GRADE C.				FIELD IV, FIBER GRADE D.			
1	0.1410	36.70	260.2	2.60	0.1390	28.50	205.8	2.60	0.1485	36.40	245.1	3.00	0.1440	36.60	254.2	3.00
2	0.1480	29.10	196.6	2.50	0.1417	34.00	240.7	3.00	0.1460	28.90	197.9	2.40	0.1470	37.10	252.4	2.80
3	0.1450	29.20	200.1	2.60	0.1385	34.80	247.7	3.00	0.1430	35.90	251.1	3.00	0.1460	38.90	266.4	3.00
4	0.1435	38.10	265.5	2.60	0.1410	35.10	248.2	3.00	0.1460	37.40	256.2	3.00	0.1490	23.90	160.4	2.40
5	0.1470	27.50	187.0	2.40	0.1420	28.50	200.7	2.60	0.1495	28.40	190.0	2.40	0.1485	34.10	229.6	2.80
6	0.1435	24.10	167.8	2.80	0.1430	30.00	209.8	2.60	0.1425	36.00	252.6	3.00	0.1420	36.00	257.7	3.00
7	0.1425	37.30	261.7	2.40	0.1460	30.20	206.8	2.60	0.1435	33.90	236.2	3.20	0.1475	34.00	230.5	2.60
8	0.1450	23.30	160.7	2.40	0.1445	34.40	238.1	2.80	0.1480	30.20	204.1	2.40	0.1475	29.50	200.0	2.80
9	0.1490	33.80	226.8	2.40	0.1430	27.70	193.7	2.40	0.1480	34.20	231.4	2.50	0.1475	35.20	238.7	2.80
10	0.1470	27.40	186.4	2.80	0.1460	32.90	225.8	2.80					0.1435	39.30	273.8	3.00
Mean			211.28	2.59			221.68	2.74			229.40	2.77			236.37	2.82
Standard deviation of single tests from the mean			±37.5				±25.1				±24.1				±32.4	

TABLE 1.—*Tensile strength of dried fibers from various leaf sheaths of the pseudostem of two kinds of abacá*—Continued.

TENSILE STRENGTH OF 20-HOUR DRIED FIBERS FROM FIVE OR SIX INNER LEAF SHEATHS OF THE PSEUDOSTEM OF PUTI TOMATAGAKAN.

Trial No.—	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.	Weight of strand 20 cm long.	Tensile strength.	Computed tensile strength per gram.	Stretch in 20 cm.
	FIELD I, FIBER GRADE D AND E.				FIELD II, FIBER GRADE D.				FIELD III, FIBER GRADE E.				FIELD IV, FIBER GRADE D.			
	g.	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*	*g.*	*kg.*	*kg.*	*P. ct.*
1	0.1440	22.40	155.6	2.60	0.1465	27.00	184.3	2.60	0.1470	27.70	188.6	2.40	0.1440	39.60	275.0	2.60
2	0.1425	30.80	216.1	3.00	0.1440	2.70	157.6	2.40	0.1500	37.00	246.7	2.80	0.1440	36.60	254.2	2.60
3	0.1435	23.00	160.3	2.60	0.1410	34.00	241.1	3.00	0.1445	33.00	233.2	2.60	0.1440	40.00	277.8	2.80
4	0.1410	34.00	241.1	2.80	0.1420	28.30	199.3	2.80	0.1470	37.50	255.1	3.00	0.1475	43.60	295.6	2.80
5	0.1500	24.30	162.0	2.40	0.1425	35.80	251.2	3.40	0.1480	28.90	195.3	2.60	0.1470	38.00	258.5	2.80
6	0.1445	37.40	259.3	3.00	0.1430	33.40	233.6	3.40	0.1530	33.10	216.3	2.60	0.1485	32.30	217.5	2.60
7	0.1445	35.60	246.4	3.30	0.1415	36.50	257.9	3.20	0.1450	31.50	217.2	2.60	0.1430	37.40	261.5	2.60
8	0.1440	37.90	263.2	3.00	0.1480	24.80	167.6	2.60	0.1480	29.30	198.0	2.60	0.1455	40.20	276.3	2.80
9	0.1410	21.80	154.6	2.20	0.1430	33.00	230.8	3.00	0.1460	36.70	251.4	2.80	0.1410	38.00	269.5	2.80
10					0.1440	31.00	215.3	2.80	0.1480	31.70	214.2	2.60	0.1440	39.50	275.0	2.80
Mean			206.45	2.77			213.87	2.72			221.60	2.66			266.09	2.72
Standard deviation of single tests from the mean			±45.0				±33.2				±24.9				±19.6	

TWO CONVENIENCES FOR PHYTOPATHOLOGICAL WORK IN THE TROPICS

By C. J. HUMPHREY

Mycologist, Bureau of Science, Manila

TWO PLATES

Soon after the writer assumed charge of investigations in plant pathology and mycology at the Bureau of Science, Manila, a need was felt for suitable apparatus for the preparation of pure cultures and for the propagation from seed of plants needed for artificial infection, as a result of which past experience was drawn upon and certain modifications made in existing appliances. As these are well adapted to our work, and may prove useful to others, they are perhaps worth recording. There is nothing new, however, in the general idea of making cultures in a closed chamber or of keeping plants under cover to maintain them free of undesirable pathogenes. What the writer wishes to point out are only certain improvements or adaptations of well-known apparatus, particularly for tropical work.

A SERVICEABLE CULTURE CASE

While in charge of timber-decay investigations at the United States Forest Products Laboratory, Madison, Wisconsin, the writer had occasion to construct several culture cases for the isolation and transfer of various organisms concerned in the deterioration of wood or wood products. Some of these cases gave considerable trouble from the swelling and subsequent shrinkage of the wood, which ultimately produced cracks at the joints, thus rendering the cases unsuitable for careful work.

A type of construction was finally developed in which the wood did not "work" undesirably. The principal source of trouble in an ordinary case lies in the bottom, which swells excessively from the application of mercuric chloride solution, or other sterilizing agents prepared with water. To overcome this a lead sheet at least ⅛-inch thick was closely fitted over the bottom, with the edge set with white lead into an upward slanting groove in the side walls of the case, about an inch from the bottom. This caused all drainage from the walls and top to

collect on the lead surface of the bottom, thus maintaining the floor boards in a dry condition and obviating all swelling and shrinkage, with its consequent pushing outward of the walls of the case. Lead was used because it is highly resistant to mercury salts.

In the construction the glass-paneled sides and back and the solid bottom were built up separately, the parts then being screwed together after coating the joints with white lead. The top was composed of 1-inch tongue-and-groove boards, also put on with screws. The vertically operating front window slid in a groove and could be adjusted to any desired height by metal pins inserted through holes in the corner of the case for the window to rest upon.

Cases which we have built in Manila differ somewhat in method of construction from the one described above, this being necessitated by the lack of suitable machines for rapid cabinet work. They are in no respect inferior, however. The framework consists of 2-by-2-inch tropical hardwood, preferably narra or guijo, and is built up of an upper and a lower rectangular frame with similar-sized members serving as corner posts. The horizontal members are lapped at the corners and the vertical posts are mortised entirely through them. This gives a very rigid frame. The double-strength window glass, or plate glass if one wishes to spend more for this item, is set into grooves running midway of the 2-by-2 framing. The glass is set in white lead. The top is made of 1-inch boards, splined.

One of our present cases (Plate 1) is 34 inches wide, 26 inches deep, and 26 inches high, this being a convenient size for handling several large culture bottles at a time. The fixed walls are made of single pieces of plate glass with a single unframed plate for the front, this sliding vertically in a groove in the corner posts. A much lighter case can be made of double-strength window glass, but the front pane needs to be set in a frame for additional strength.

When operating the case, the front window is raised and two boards having elliptical holes approximately 5 by 8 inches, spaced 15-inch centers, are inserted. The window rests in a groove in these. From this joint a curtain hangs somewhat below the bottom of the case. As an additional safeguard in preventing the entrance of contaminating organisms the arm openings in the boards are made smaller by tacking to the inside of the hole a pad of cotton surfaced with light cloth, leaving a slit for the hand.

It has been found that such a case is so tight that not sufficient air can enter to maintain a Bunsen flame for more than ten or fifteen minutes. It is therefore necessary to force compressed air into the case in considerable volume. This is a simple procedure at the Bureau of Science, since all the rooms are piped for this convenience. The compressed air is bubbled vigorously through a suction flask about one-fourth filled with a 1: 1000 mercuric chloride solution. It enters at the top of the case and is discharged horizontally along the roof. This supplementary apparatus serves three purposes; 1, supplies oxygen for the burner; 2, furnishes sterile moisture-laden air in which one can operate under aseptic conditions; and 3, the forced entrance of air creates a positive pressure from within and prevents the entrance of contaminating air by suction through the arm holes.

CELLULOID CYLINDERS FOR GROWING YOUNG PLANTS

Many of the plant diseases in the Philippines are so widely distributed and so little under control, even at propagation centers, that if one is to secure healthy plants for testing the pathogenicity of strains or species of the various organisms it becomes absolutely necessary to start with disease-free seed and grow the plants within a closed transparent container. Under the conditions of extreme insolation and high temperatures in the Tropics glass bell jars, or similar close containers, are very detrimental to the growth of the plants. The curved surface of a bell jar acts more or less as a condensing lens so that the accumulation of heat within becomes excessive; also the oxygen-carbon dioxide balance becomes seriously disarranged. As a result normal plants are rarely produced.

To mitigate this difficulty the writer introduced the use of celluloid cylinders (Plate 2) and these have proven very serviceable in our investigations on cacao, mango, truck crops,[1] etc. For the preparation of these cylinders we use standard-sized celluloid sheets, 20 by 50 inches, such as are used in automobile curtains. They are cemented with ethyl acetate, which acts as a welding-solvent for the material. A standard sheet makes a cylinder either 20 inches high by 15⅞ inches in diameter or 40 by 6¼ inches, allowing ½ inch for the lap. They can be built up to any size, however, by the simple process of cementing the edges. This should be done carefully and rapidly, and the seams

[1] See Fajardo, T. G., and J. Marañon, Philip. Journ. Sci. 48 (1932) 133.

kept under pressure long enough for the softened materials to dry and consolidate.

The cylinders are kept true in form by the insertion of circles of heavy galvanized wire, bevelled and soldered at the joint, and placed about 1 or 1.5 inches from the ends. When in use a thin, sterile cloth of rather fine weave is tied over the top and the cylinder is pushed slightly into the soil of the pots containing the plants or germinating seeds. A layer of coarse sand covering the soil outside the cylinder will aid in preventing soil contamination but is hardly necessary if sterilized water be used during the growth of the plants. Needless to say, the soil and pots should both be sterilized before using.

Celluloid has been used in the United States, and probably elsewhere, for various purposes in plant pathology, and was first called to the writer's attention through its application by E. E. Hubert[2] as a protection, both in the greenhouse and in the field, for branches of forest trees after inoculation with rusts or other pathogenes.

In the Tropics the life of celluloid is rather short, usually around two years, after which it becomes quite brittle and cracks when carelessly handled. The cheaper grades of glass also depreciate rapidly on continuous exposure to varying atmospheric conditions, besides being subject to breakage at all times. A celluloid sheet of the size indicated costs in Manila 2.25 pesos (1.125 dollars), while a tall form of bell jar of much smaller size, 18 inches high, 10 inches in diameter, but of good quality glass, is listed at 10.80 dollars in the United States in case lots. Even though the latter were as suitable their cost would be prohibitive where several hundred may be needed at one time.

[2] Phytopath. 6 (1916) 447–449.

ILLUSTRATIONS

Plate 1

Fig. 1. Plate-glass case now in use for plant-pathology work. Note the single vertically sliding pane in front and the suction flask at the top containing a 1:1000 solution of mercuric chloride. Compressed air is forced through this solution into the case.

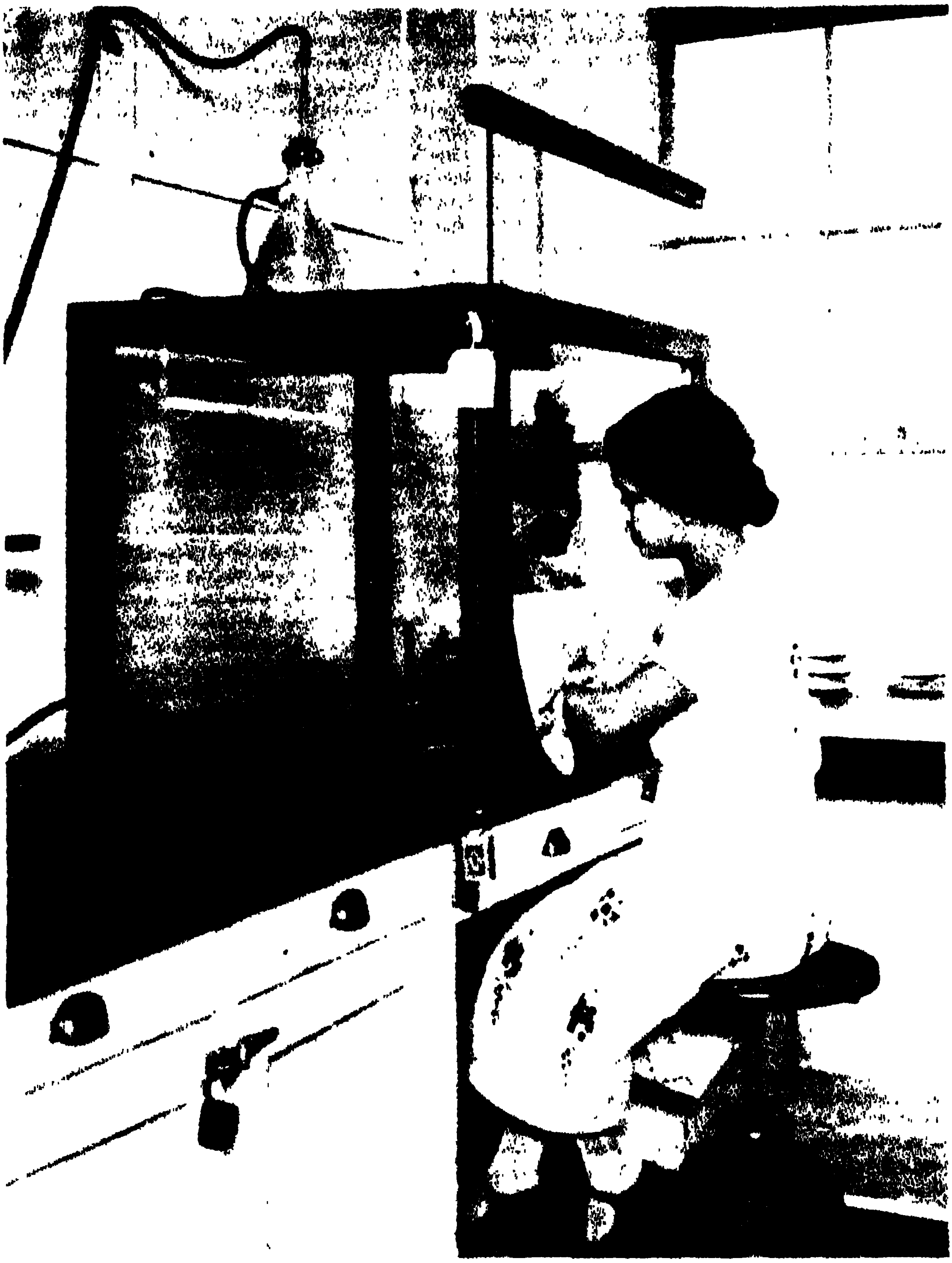
2. Floor of the case, covered with sheet lead to prevent wetting of the boards.

Plate 2

Fig. 1. Celluloid cylinder $15\frac{3}{8}$ inches in diameter and 20 inches high. The sheet is cemented at the edges with ethyl acetate. The galvanized wire rings are inserted to hold the form.

2. One of the cylinders in use for growing mango seedlings. It is pressed slightly into the soil of the pot and the top is covered with finely woven cotton cloth.

3. Two cylinders of the same height but only $6\frac{1}{4}$ inches in diameter used for growing tomato plants. These plants are not of the bush type and therefore appear rather spindling.



PLATE

AVIAN MALARIA STUDIES, IV

HÆMOPROTEUS AND PLASMODIUM IN BIRDS OF LUZON PHILIPPINE ISLANDS [1]

By Paul F. Russell

Of the International Health Division of the Rockefeller Foundation

INTRODUCTION

Plasmodium and *Hæmoproteus* infections in birds are not at all uncommon. Huff(1) in 1927, for example, had records of *Plasmodium* infections in seventy-nine species of birds. He estimated that there have been twice as many records of *Hæmoproteus* infections. Hegner and Chu(2) published a survey of protozoan parasites in animals and plants of the Philippines and gave a list of 95 birds belonging to 47 species. In seven birds they found *Hæmoproteus* and in three *Plasmodium.*

It was a matter of interest, in connection with other avian malaria studies, to obtain further information as to the prevalence of *Hæmoproteus* and *Plasmodium* infections in Philippine birds. I am indebted to Mr. R. C. McGregor, chief of the division of zoölogy, Bureau of Science, first, for making it possible to take blood smears from birds caught by his field staff, and secondly, for the identification of bird species.

Between July, 1930, and December, 1931, blood smears were taken from over six hundred birds of more than forty species caught in the City of Manila, and in Bulacan, Rizal, and Nueva Ecija Provinces, Luzon Island, Philippine Islands. These smears were subjected to Giemsa's stain and examined with the results shown in Table 1.

From this table it will be noted that of the six hundred four birds examined sixty, or about 10 per cent, were positive for parasites of the genus *Plasmodium.* Organisms of the genus *Hæmoproteus* were found in one hundred seventeen, or in about

[1] This survey was made in the laboratory of malaria investigations, jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. Assisting in the microscopy were Misses Amparo Capistrano, chief microscopist, and Filomena Villacorta, microscopist. The drawings were made by Miss Lourdes Moskaira, special technician.

19 per cent of the smears. In one hundred six, or about 18 per cent of the cases, a mixed infection of *Plasmodium* and *Hæmoproteus* was diagnosed.

CLASSIFICATION

Wenyon (3) classifies the genera *Hæmoproteus* and *Plasmodium* as follows:

Phylum PROTOZOA Goldfuss, 1817.
  Subphylum: PLASMODROMA Doflein, 1901.
    Class SPOROZOA Leuckart, 1879.
      Subclass COCCIDIOMORPHA Doflein, 1901.
        Order COCCIDIIDA Labbé, 1899.
          Suborder HÆMOSPORIDIIDEA
A. Family HÆMOPROTEIDÆ Doflein, 1916.
  1. Genus *Hæmoproteus* Kruse, 1890.
  2. Genus *Leucocytozoön* Danilewsky, 1890.
B. Family PLASMODIIDÆ Mesnil, 1903.
  1. Genus *Plasmodium* Marchiafava and Celli, 1885.

HÆMOPROTEUS

Parasites diagnosed as belonging to the genus *Hæmoproteus* were found, as shown in Table 1, in the following birds:

Aluco longimembris. Grass owl.
Excalfactoria lineata. Island painted quail.
Munia cabanisi. Cabanis's weaver.
Numenius variegatus. Eastern whimbrel.
Rallina eurizonoides. Philippine banded crake.
Totanus eurhinus. Asiatic redshank.
Turnix fasciata. Philippine button quail.

In Plate 1 are figured *Hæmoproteus* organisms as seen in the grass owl and the island painted quail. No marked differences in morphology were observed between any of the *Hæmoproteus* of these Philippine birds and the illustrations given by Wenyon (4) of *Hæmoproteus columbæ* Celli and Sanfelice, 1891. But it cannot be stated that the species observed is or is not the classical species. No transmission experiments were done with the fly *Lynchia maura.* Blood inoculations from birds with *Hæmoproteus* infections as usual did not result in the transmission of this parasite.

PLASMODIUM

As noted in Table 1, *Plasmodium* was represented in the following birds:

Aluco longimembris. Grass owl.
Excalfactoria lineata. Island painted quail.
Munia cabanisi. Cabanis's weaver.

Numenius variegatus. Eastern whimbrel.
Rallina eurizonoides. Philippine banded crake.
Totanus eurhinus. Asiatic redshank.
Turnix fasciata. Philippine button quail.

Morphologically, these avian plasmodia all seem to belong to one or the other of two species; namely, *P. elongatum* Huff, 1930, and *P. capistrani* sp. nov., 1932. In three cases of seven attempts plasmodium was transmitted by blood inoculations to canaries (*Serinus canarius*). The first transmission was made August 4, 1930, from an island painted quail (*Excalfactoria lineata*). The plasmodium established itself in the canary and has been successfully propagated from that time to the present (November, 1931). This plasmodium apparently belongs to a new species. In another report(5) it has been called *P. capistrani* sp. nov., 1932, and accompanying the description are some biological notes which, I believe, indicate that a specific status is justified.

November 7 a second successful transmission of *P. capistrani* was made from an island painted quail into two canaries, C12 and C13.

July 31, 1931, a successful transmission was made into a canary from the Philippine button quail (*Turnix fasciata*). This plasmodium, which has an elongate gametocyte, is believed to be *P. elongatum* Huff, 1930. In the first place it is morphologically similar in its asexual development and in its crescentic gametocytes (see Plate 2). In the second place it has not been possible, in three attempts, to cross-infect in either direction this plasmodium with one known to be *P. elongatum* Huff. The known species was secured through the courtesy of Dr. C. G. Huff in 1929 and has been carried along in the laboratory since that time.

REMARKS

No parasites of the genus *Leucocytozoon* were observed. No blood parasites were found in 130 mountain sparrows (*Passer montanus*), a common bird in Manila. *Plasmodium relictum* Grassi and Feletti, 1891, was not diagnosed, although it is reported as common in tropical and subtropical countries. It is possible, of course, that in some of the quail this plasmodium was present as well as *P. capistrani* sp. nov. It is doubtful if the two species could be distinguished in some stages of development. This question and that of validity of species in avian malaria, are considered in another paper.(5)

TABLE 1.—*Wild birds examined for blood parasites.*

Bird.			Birds examined.	Plasmodium.		Hæmoproteus.		Mixed infection.	
Serial No.	Scientific name.	Common name.		Birds positive.	Percentage positive.	Birds positive.	Percentage positive.	Birds positive.	Percentage positive.
1	*Acanthopneuste borealis*	Northern willow warbler	1	0	0	0	0	0	0
2	*Accipiter confusus*	Philippine sparrow hawk	1	0	0	0	0	0	0
3	*Accipiter manillensis*	do.	1	0	0	0	0	0	0
4	*Aluco longimembris*	Grass owl	3	1	33	2	67	1	33
5	*Amaurornis olivacea*	Philippine waterhen	1	0	0	0	0	0	0
6	*Anas* sp.	Domestic duck	12	0	0	0	0	0	0
7	*Bubulcus coromandus*	Cattle egret	2	0	0	0	0	0	0
8	*Cephalophoneus nasutus*	Large-nosed shrike	2	0	0	0	0	0	0
9	*Chalcophaps indica*	Indian bronze-winged dove	4	0	0	0	0	0	0
10	*Cinnyris jugularis*	Yellow-breasted sunbird	1	0	0	0	0	0	0
11	*Cyornis philippinensis*	Philippine cyornis	1	0	0	0	0	0	0
12	*Egretta garzetta*	Little white egret	2	0	0	0	0	0	0
13	*Excalfactoria lineata*	Island painted quail	158	46	29	96	61	95	60
14	*Gallinago megala*	Swinhoe's snipe	23	0	0	0	0	0	0
15	*Geopelia striata*	Barred ground dove	3	0	0	0	0	0	0
16	*Halcyon gularis*	White-throated kingfisher	1	0	0	0	0	0	0
17	*Haliastur intermedius*	Malayan brahminy kite	2	0	0	0	0	0	0
18	*Hypotaenidia philippensis*	Pectoral rail	5	0	0	0	0	0	0
19	*Hypotaenidia striata*	Blue-breasted rail	38	0	0	0	0	0	0
20	*Hypotaenidia torquata*	Philippine rail	4	0	0	0	0	0	0
21	*Hypothymis occipitalis*	Black-naped flycatcher	1	0	0	0	0	0	0
22	*Ixobrychus astrologus*	Little yellow bittern	1	0	0	0	0	0	0
23	*Lalage melanoleuca*	Black and white lalage	1	0	0	0	0	0	0
24	*Leucotreron leclancheri*	Black-chinned fruit pigeon	1	0	0	0	0	0	0
25	*Limnobaenus fuscus*	Ruddy crake	2	0	0	0	0	0	0

26	*Mirafra philippinensis*	Philippine bush lark	1	0	0	0	0	0	0
27	*Munia cabanisi*	Cabanis's weaver	61	1	2	3	5	2	3
28	*Munia jagori*	Philippine weaver	12	0	0	0	0	0	0
29	*Numenius variegatus*	Eastern whimbrel	24	2	8	1	4	1	4
30	*Nycticorax nycticorax*	Common night heron	8	0	0	0	0	0	0
31	*Oriolus acrorhynchus*	Philippine oriole	1	0	0	0	0	0	0
32	*Orthotomus derbianus*	Derby's tailorbird	1	0	0	0	0	0	0
33	*Otomela lucionensis*	Gray-headed shrike	2	0	0	0	0	0	0
34	*Padda oryzivora*	Java sparrow	4	0	0	0	0	0	0
35	*Passer montanus*	Mountain sparrow	130	0	0	0	0	0	0
36	*Phapitreron leucotis*	Northern white-eared pigeon	1	0	0	0	0	0	0
37	*Pluvialis fulvus*	Pacific golden plover	1	0	0	0	0	0	0
38	*Pratincola caprata*	Pied chat	1	0	0	0	0	0	0
39	*Rallina eurizonoides*	Philippine banded crake	10	1	11	5	56	1	11
40	*Rostratula capensis*	Painted snipe	18	0	0	0	0	0	0
41	*Spilornis holospilus*	Philippine serpent eagle	1	0	0	0	0	0	0
42	*Sturnia sinensis*	Gray-backed starling	1	0	0	0	0	0	0
43	*Totanus eurhinus*	Asiatic redshank	5	1	20	1	20	1	20
44	*Turnix fasciata*	Philippine button quail	31	8	26	9	29	5	16
45	*Turnix ocellata*	Spotted button quail	21	0	0	0	0	0	0
46	*Turnix whiteheadi*	Whitehead's button quail	4	0	0	0	0	0	0
	Total [a]		604	60	10	117	19	106	18

[a] Species examined, 46; species with malaria plasmodia, 7.

SUMMARY

The results of the examination of some six hundred blood smears from wild-caught birds are reported. In a number of cases parasites of the genera *Hæmoproteus* and *Plasmodium* were found. These parasites apparently belong to the species *H. columbæ* Celli and Sanfelice, 1891; *P. elongatum* Huff, 1930; and *P. capistrani* sp. nov., 1932.

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AVIAN MALARIA STUDIES, V

PLASMODIUM CAPISTRANI SP. NOV., AN AVIAN MALARIA PARASITE IN THE PHILIPPINES [1]

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TWO PLATES AND ONE TEXT FIGURE

INTRODUCTION

In the course of a survey of *Hæmoproteus* and *Plasmodium* infections in Philippine birds, as reported in a previous paper, (1) a parasite was encountered in a quail which is apparently a new species of plasmodium. This organism has been observed for more than a year and is now being presented as *Plasmodium capistrani* sp. nov.

NOMENCLATURE

There is a great deal of confusion at present as to the number of species and the proper names of the avian malaria parasites. The situation has become so complex that it urgently requires official clarification. In this paper the question will not be considered to any greater extent than seems absolutely necessary as a background. Unfortunately, it will not be possible to relieve any of the confusion. However, it is believed that the specificity of the new parasite of bird malaria reported hereunder has been proved, so that there need be no fear of further beclouding the issue.

Six species of avian malaria parasites have, I believe, justifiable claims to specific names at the present time. They are as follows:

[1] This study was made in the laboratory of malaria investigations, jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. The author was assisted in microscopy by Misses Amparo Capistrano, chief microscopist, and Filomena Villacorta, microscopist; in mosquito transmission by Mr. Andres Nono, chief field assistant. The drawings are the work of Miss Lourdes Moskaira, special technician. This paper was read before a regular meeting of the Philippine Society of Parasitology, November 21, 1931.

1. *Plasmodium relictum* Grassi and Feletti, 1891. This is, I believe, identical with the parasite isolated by Whitmore in 1913. It is *P. inconstans* Hartman, 1927. This parasite has been and is often called *P. præcox*. It has had an average incubation period in one hundred canaries, in my experience, of eight or nine days. The gametocytes are not crescentic and their pigment granules are usually somewhat more spherical than cylindrical.

2. *Plasmodium cathemerium* Hartman, 1924. This parasite, like *P. relictum*, does not have crescentic gametocytes. The pigment granules in *P. cathemerium* are usually somewhat more cylindrical than spherical. The average incubation period in several hundred canaries, in my experience, has been about five days. Cross inoculations can be done between *P. relictum* and *P. cathemerium*. The relations, however, are not reciprocal, for Gingrich(2) reports that *P. cathemerium* inoculated into birds with latent infections of *P. relictum* produced no demonstrable infection but subinoculations showed both *P. cathemerium* and *P. relictum*. On the other hand, in his experience, *P. relictum* inoculated into birds with latent infections of *P. cathemerium* produced an infection somewhat lower than control infections in normal birds.

3. *P. rouxi* Sergent and Catanei, 1928.

4. *P. circumflexum* Kikuth, 1931. Both *P. rouxi* and *P. circumflexum* have been studied by Huff(3) in association with *P. relictum*, *P. cathemerium*, and *P. elongatum* and he is convinced of their specific validity.

5. *Plasmodium elongatum* Huff, 1930. This parasite is distinguished by its crescentic gametocytes. It has a longer incubation period, averaging in one hundred canaries, in my experience, ten days. This species is *P. præcox* of Huff, 1926, of Hartman, 1927. It is thought by some to be *P. præcox* of Grassi and Feletti, 1890. It is certainly distinct from *P. relictum* and *P. cathemerium* described above. Cross infection with either or both of those species can be done.

6. *Plasmodium capistrani* sp. nov., described hereunder.

Other avian plasmodia have been described; for example, *P. majoris* of Laveran, 1902 and *P. vaughani* of Novy and McNeal, 1907. It seems impossible, however, at the present time to give these last-named parasites more than a doubtful specific status.

For discussions of one phase or another of this question of the specific names and status of the avian malaria plasmodia refer to Hartman,(4) Huff,(5, 6, 7) and Schuurman.(8)

DESCRIPTION

PLASMODIUM CAPISTRANI sp. nov. Plates 1 and 2.

Morphology.—With Giemsa's stain the parasites are clearly distinguished in the cytoplasm of the red blood cell. The trophozoites are usually at either end of the erythroblast or, frequently, of the erythrocyte. Occasionally two, and rarely three, young trophozoites have been seen in the same blood cell. The older parasites tend to displace or completely to dislodge the nucleus of the red cells. Pigment is usually present and seems to be more abundant than in the other three species of avian malaria parasites. It is more often cylindrical or cone-shaped than spherical and it tends to clumping. Vacuoles are not uncommon. Segmenting forms are common in the peripheral blood and there are from eight to sixteen merozoites.

Both microgametocyte and macrogametocyte are spherical in shape. No crescentic gametocytes are formed. The gametocytes are usually in the apex of the cell, which is often distorted. The nucleus of the red cell is always pushed aside and may lie transversely or it may be absent. The cytoplasm of the microgametocyte stains more faintly blue than that of the macrogametocyte with Giemsa's stain. Chromatin is abundant in each and tends to be somewhat scattered, although it is sometimes more compactly arranged in the macrogametocyte. Pigment is abundant in both gametocytes and is scattered throughout the cytoplasm. It seems to be more prominent than in the other species of malaria plasmodia (see Plate 1).

Oökinetes have not been studied. Oöcysts are similar to those of other malaria plasmodia, as are also the sporozoites (see below and also Plates 2 and 3).

Type locality.—Novaliches, Rizal Province, Philippine Islands.

Type host.—*Excalfactoria lineata*, island painted quail.

PATHOGENICITY

Reference to Table 1 reveals some interesting points in regard to the pathogenicity of *P. capistrani* in canaries. It will be seen that in the first twenty-five attempts to infect canaries by blood inoculation (birds C1 to C33 August 4, 1930, to July 8, 1931), there were seven (28 per cent) negative results. In the next thirty-nine attempts there were only six (15 per cent) failures.

But the most striking feature is the fact that among the eighteen successful infections in the first twenty-five attempts,

TABLE 1.—*Clinical data from canaries infected with Plasmodium capistrani sp. nov.*

[*Modes of infection:* 1. By needle inoculation of blood-saline mixture intramuscularly. 2. By the bite of *Culex quinquefasciatus* (*fatigans*). 3. By needle inoculation of saline suspension of macerated thorax tissues of *Culex quinquefasciatus* (*fatigans*). Numbers missing from this table were on birds which either died within four days of inoculation or were used with other plasmodia than *P. capistrani* sp. nov. All birds used with *P. capistrani* and living more than four days after inoculation have been included in the table.]

Canary.	Inoculation.				Results of examinations of blood smears.			
	Date.	Mode.	Source of inoculum.	Result.	Negative.	+	++	+++
	1930							
C1	Aug. 4	1	EL5	P	Aug. 4 to 14	Aug. 15 to 20		
C2	Aug. 18	1	C1	P	Aug. 18, 24	Aug. 25 to 30		
C3	do.	1	C1	P	Aug. 18 to 26	Aug. 27		
C4	Aug. 28	1	C2	P	Aug. 28 to Sept. 2	Sept. 3 to 11		
C5	do.	1	C2	P	Aug. 28 to Sept. 7	Sept. 8, 9		
C8	Sept. 5	1	C4	P	Sept. 5 to 19	Sept. 20, 24		
C9	do.	1	C4	P	Sept. 5 to 11 and Sept. 13–18	Sept. 12 and Sept. 19–24		
	1931							
C18	Feb. 16	1	C4	N	Feb. 16 to Mar. 4			
C19	do.	1	C4	P	do.	Mar. 5		
C20	Mar. 5	1	C19	N	Mar. 5 to Apr. 4			
C20	Mar. 23	1	C1	P	do.	Apr. 6 to 11		
C21	Mar. 5	1	C19	N	do.			
C21	Mar. 23	1	C1	N	do.			
C22	do.	1	C5	N	Mar. 23 to 31			
C23	do.	1	C5	N	Mar. 23 to Apr. 1			
C24	Apr. 8	1	C20	P	Apr. 8 to 18	Apr. 20 to 25		
C25	do.	1	C20	P	Apr. 8 to 16	Apr. 18 to 22		
C26	Apr. 21	1	C24	P	Apr. 21 and 28	Apr. 29 to May 4		
C27	do.	1	C24	P	Apr. 21 to May 2	May 4 and 11		
C28	May 11	1	C26	P	May 11 to 22	May 24 to June 1		

C28	....do........		C28	N	May 11 to July 16........	....	....	....
C29	July 16........		C25	P	May 11 to July 22........	July 23 to 29........	....	....
C30	June 1........		C28	P	June 1 to 9........	June 11 and 13........	....	....
C31	....do........		C28	P	June 1 to 15........	June 17 to 23........	....	....
C33	July 8........		C5	P	July 8 to 17........	July 18........	....	....
C34	July 16........		C25	P	July 16 to 22........	July 23 to 29........	....	....
C35	July 27........		C34	P	July 27 to Aug. 3........	Aug. 4........	....	Aug. 8, 10, 11, 12........
C36	....do........		C34	P	July 27 to Aug. 3........	....do........	Aug. 11........	Aug. 5, 7........
C39	Aug. 5........		C5	P	Aug. 5, 13........	Aug. 14, 15........	....	....
C40	....do........		C5	P	Aug. 5, 11........	Aug. 12........	....	....
C46	Aug. 31........		C35	N	Aug. 31 and Sept. 7–12........	....	....	....
C47	Sept. 1........		C35	P	Sept. 1 to 8........	Sept. 9, 10........	....	....
C48	....do........		C35	P	....do........	Sept. 9 to 12........	....	....
C49	Sept. 4........		C35	N	Sept. 4 to 16........	....	....	....
C52	Sept. 8........		C35	N	Sept. 8 to Oct. 2........	....	....	....
C53	Sept. 15........		C48	P	Sept. 15 to 21........	Sept. 22........	Sept. 30........	....
C54	....do........		C48	P	Sept. 15 and 22........	Sept. 23 to Oct. 2........	....	....
C66	Sept. 26........		C29	P	Sept. 26 and Oct. 4........	Oct. 5 and 7........	....	....
C67	....do........		C29	P	Sept. 26 and Oct. 5........	Oct. 6–9........	Oct. 17, 20........	Oct. 13........
C68	....do........		C29	P	....do........	Oct. 6, 7........	....	Oct. 9........
C69	....do........		C29	P	....do........	....do........	....	....
C71	Oct. 12........		C48	P	Oct. 12, 20........	Oct. 21........	....	....
C73	Oct. 15........		C48	P	Oct. 15, 26, 28, 29........	Oct. 29, 30........	....	....
C77	....do........		C48	N	Oct. 15, 27–31 and Nov. 2–9........	....	....	....
C78	....do........		C48	P	Oct. 15, 27–31........	Nov. 1, 2........	....	Nov. 4........
C80	....do........		C48	N	Oct. 15, 27–31 and Nov. 3–9........	....	....	....
C81	....do........	3	C48	N	....do........	....	....	....
C82	....do........	2	C48	P	Oct. 15, 24, 25, 26........	Oct. 27, 29, 31........	....	....
C83	....do........	2	C48	P	Oct. 15, 24........	Oct. 25........	Oct. 27, 29........	....
C84	Oct. 23–24........	2	C48	N	Oct. 23 and Nov. 3, 5, 7, 9, 10, 13, 16, 18, 20, 24........	....	....	....
C85	....do........	2	C48	N	....do........	....	....	....
C86	Oct. 27........	1	C71	P	Oct. 27, and Nov. 1–3........	Nov. 4........	....	....
C87		1	C71	P	Oct. 27, and Nov. 1........	....	Nov. 2........	....
		1	C71	P	....do........	....	Nov. 2, 3........	....

TABLE 1.—*Clinical data from canaries infected with Plasmodium capistrani sp. nov.*—Continued.

Canary.	Inoculation.				Results of examinations of blood smears.			
	Date.	Mode.	Sources of inoculum.	Result.	Negative.	+	++	+++
	1931							
C89	Nov. 2	1	C83	P	Nov. 2, 7, 8	Nov. 9, 10		
C90	do	1	C83	P	do	do	Nov. 12	
C91	do	1	C83	P	Nov. 2	Nov. 7, 9, 10	do	
C92	do	1	C83	P	Nov. 2, 7, 8, 9	Nov. 10	do	Nov. 16
C96	Nov. 13	1	C39		Nov. 13, 19, 21, 23, 25			
C97	do	1	C39	P	do	Nov. 25		
C98	do	1	C39		do			
C99	do	1	C67	P	Nov. 13, 19	Nov. 21, 23		
C100	do	1	C67	P	do	Nov. 21	Nov. 23	
D1	do	1	C67	P	do	do	do	

Canary.	Results of examinations of blood smears—Continued.				Length of prepatent period.	Died.	Remarks.
	++++	+++++	+	Negative.			
					Days.		
C1				Aug. 21, 1930 to Mar. 30, 1931	11	July 2, 1930	
C2				Sept. 16, 1930 to Mar. 18, 1931	7	Mar. 20, 1931	
C3					9	Aug. 28, 1930	
C4				Sept. 13, 1930 to Mar. 18, 1931	6	Mar. 20, 1931	
C5			June 30 and July 8, 1931	Sept. 11, 1930 to Mar. 23, July 22 and Aug. 4	11	Aug. 12, 1931	
C6					15	Sept. 25, 1930	

C9			Feb. 10, 1931	Sept. 30, 1930. Oct. 22, 1930. Jan. 2, 1931	7	Feb. 12, 1931	All dates 1931 hereafter.
C18						Mar. 5	
C19				Mar. 6 to 19	16	Mar. 20	
C20						June 30	
C20				June 30	14	June 30	
C21						Apr. 5	
C21						do	
C22						Apr. 1	
C23						Apr. 3	
C24				July 8	11 or 12	July 20	
C25			July 8, 14, 16, 22, Aug. 10	July 24	9 or 10	Aug. 30	
C26				May 11, July 8, Aug. 4, Sept. 28 to Oct. 9	7		Alive Nov. 25, 1931.
C27			Aug 4	July 8	12 or 13	Aug. 10	
C28				June 30	12 or 13	July 8	
C29						Nov. 22	
C29			Sept. 29	Aug. 10, Sept. 26 to 28	7	do	
C30				June 15 to 18	9 or 10	June 28	
C31					15 or 16	June 27	
C33			July 23 to 25	July 20–22, Aug. 10	10	Aug. 17	
C34	July 31, Aug. 1 and 3.		Aug. 5 and 10	Aug. 30	7	Sept. 13	
C35	Aug. 5, 7, 13	Aug. 6, 14, 15			8	Aug. 16	
C36	Aug. 6		Aug. 8, 10, 12	Sept. 15	8	Nov. 2	
C39			Nov. 17	Nov. 13	9		Alive Nov. 25, 1931.
C40	Aug. 19, 21	Aug. 14, 15	Sept. 26	Sept. 27, 28, 29	7	Nov. 12	
C46						Sept. 13	
C47			Sept. 14	Sept. 11, 12, 15–19	8	Oct. 13	
C48	Sept. 14	Sept. 15 to 21			8	Sept. 23	
C49				Nov. 14			Alive Nov. 25, 1931.
C52						Oct. 13	
C53	Sept. 28	Sept. 23, 25	Oct. 2		7	do	
C54					8	do	

TABLE 1.—*Clinical data from canaries infected with Plasmodium capistrani sp. nov.*—Continued.

Canary.	Results of examinations of blood smears—Continued.				Length of prepatent period.	Died.	Remark
	++++	+++++	+	Negative.			
					Days.		
C66	Oct. 9		Oct 13, 15, 17, 20, 24	Nov. 17	9		Alive Nov. 25,
C67	Oct. 24		Oct. 15	Nov. 13, 17	10		Do.
C68			Oct. 13, 15, 17, 20	Oct. 24	10		Do.
C69			Oct. 13, 15, 17, 20, 24	Oct. 9, Nov. 17	10		Do.
C71		Oct. 26, 27, 28, 30			9	Oct. 31	
C73				Nov. 1, 2, 3, 5, 6, 9	14	Nov. 11	
C77						do	
C78	Nov. 6	Nov. 7, 9			17	Nov. 9	
C80				Nov. 14		Nov. 19	
C81				do		Nov. 15	
C82				do	12		Alive Nov. 25, 1931.
C83			Oct. 31	Nov. 2 and 14	10		Do.
C84							Do.
C85							Do.
C86	Nov. 6, 7		Nov. 9		8	Nov. 11	
C87	Nov. 3	Nov. 4			6	Nov. 5	
C88					6	Nov. 4	
C89	Nov. 12				7	Nov. 19	
C90	Nov. 13	Nov. 14, 16			7		Alive Nov. 25, 1931.
C91	Nov. 14	Nov. 16, 20			5	Nov. 22	
C92	do				8		Alive Nov. 25, 1931.
C96							Do.
C97					11 or 12		Do.
C98							Do.
C99					7 or 8		Do.
C100					7 or 8		Do.
D1	Nov. 24				7 or 8		Do.

blood smears were never more than one plus. At no time during repeated passages from the first recovery of the parasite in August, 1930, until July, 1931, was a blood smear ever more than one plus in degree of infection.

Smears were diagnosed in accordance with the following rules:

+	Positive in thirty minutes or less.
++	Two parasites per field found twice in one minute.
+++	Three parasites per field found more than three times in one minute.
++++	Four parasites per field found more than four times in one minute.
+++++	Ten or more parasites per field on the average.

What this scheme actually means may be estimated from Table 2.

TABLE 2.—*Intensity grouping of blood smears.*

Groups.	Smears counted.	Parasites per 10,000 red blood cells.
+	74	15
++	19	170
+++	18	320
++++	15	560
+++++	44	1,820

However, beginning in bird C34 infected July 16, 1931, this *P. capistrani* began to show an increased pathogenicity for canaries. Bird C34, for example, was + + + + July 31, August 1, and 3; canary C35 was + + + August 8, 10, 11, and 12; + + + + August 5, 7, and 13; + + + + + August 6, 14, and 15. Thereafter, it became the usual thing to find these more intense infections.

Reference to the chart shows that there were two main lines of transmission from bird C1. One line was through C2, the other through C20. It is interesting that along each line it was on the fourth passage from the original quail, EL5, that the parasite began to show an increase in pathogenicity for the canary.

PREPATENT PERIOD

Some information about the prepatent period may be gained from Table 1. This period has varied considerably in *P. capistrani*, as it does in all of the avian malarias when infection is transferred by intramuscular injections. It is not safe to draw

any conclusion as to a change in the incubation period of this parasite during the period of observation. The average incubation period is approximately nine days.

PERIODICITY

A brief attempt has been made to determine the periodicity of *P. capistrani* but, like *P. relictum*, its periodicity is not clearly defined. In Tables 3 and 4 are presented the results of two series of parasite counts in this connection, made on birds C40 and C90. There is no well-marked cycle revealed in these two-hourly parasite counts. Before making any definite statement in this regard it would be necessary to make such a study as that of Taliaferro.(9)

TABLE 3.—*A series of parasite counts on bird C40 (infected with P. capistrani) to determine periodicity, if any, of segmentation.*

Date.	Hour. a. m.	Hour. p. m.	Red cells counted.	Segmenters and pre-segmenters counted.	Total parasites counted.	Parasites per 10,000 red blood cells.	Segmenters and pre-segmenters per 10,000 red blood cells.
August 14, 1931	12	..	187	0	19	1,016	0
Do	..	2	330	3	26	787	91
Do	..	4	200	4	30	1,500	200
Do	..	6	211	8	28	1,327	379
Do	..	8	217	8	35	1,613	369
Do	..	10	219	5	31	1,416	218
Do	..	12	235	5	33	1,404	213
August 15, 1931	4	..	206	5	34	1,650	243
Do	6	..	204	5	27	1,324	245
Do	8	..	216	3	27	1,250	139
Do	10	..	199	2	28	1,407	101
Do	12	..	201	1	43	2,139	50
Do	..	2	210	4	35	1,667	190
Do	..	4	210	5	43	2,048	238
Do	..	6	211	1	36	1,706	47
Do	..	8	204	3	29	1,422	147
Do	..	10	171	3	46	2,690	175
Do	..	12	199	4	41	2,060	201
August 16, 1931	2	..	218	3	38	1,743	138
Do	4	..	196	2	44	2,245	102
Do	6	..	211	4	41	1,943	190
Do	8	..	215	4	32	1,488	186
Do	10	..	209	3	37	1,770	145
Do	12	..	227	3	47	2,070	132

Table 4.—A series of parasite counts on bird C90 to determine periodicity, if any, of segmentation.

Date.	Hour. a. m.	Hour. p. m.	Red cells counted.	Segmenters and pre-segmenters counted.	Parasites counted.	Parasites per 10,000 red blood cells.	Segmenters and pre-segmenters per 10,000 red blood cells.
November 12, 1931			8,465		23	27	7
Do	10		5,848		22	38	2
Do	12		7,452		24	32	7
Do			5,658		22	39	7
Do			2,960		21	71	14
Do		6	2,210	2	25	113	27
Do		8	2,910		26	89	14
Do		10	2,937		24	82	7
Do	..	12	1,900		29	153	26
November 13, 1931	2	..	962		23	239	21
Do	4	..	541	4	23	425	92
Do	6	..	536	1	23	429	93
Do	8	..	518	3	23	444	116
Do	10	..	488	2	24	492	41
Do	12		347	2	22	634	173
Do		2	321	0	21	654	31
Do		4	332	2		693	60
Do	..	6	336	3	21	625	89
Do	..	8	251	1	26	1,036	40
Do	..	10	181	4	21	1,160	276
Do	..	12	203		23	1,133	99
November 14, 1931	2	..	184		22		163
Do	4	..	185	4	27	1,459	216
Do	6	..	174	2	24	1,379	115
Do	8	..	222	1	24	1,081	90
Do	10	..	206	2	21	1,009	146
Do	12	..	182	1	23	1,264	110

MOSQUITO TRANSMISSION

Bird C35 was exposed to the bites of some *Culex quinquefasciatus* (*fatigans*) mosquitoes during the nights of August 11 and 12, 1931. Blood smears from this bird were + + + for *P. capistrani* each day. There were, respectively, forty-four and fifty-four gametocytes per ten thousand red blood cells these days. The dissection record of the mosquitoes is shown in Table 5. Of the fifteen mosquitoes dissected, eight and nine days after feeding, seven were found to have oöcysts (see Plate 2).

The salivary glands of one hundred thirty-eight mosquitoes were dissected and eleven were found to contain sporozoites, a rate of about 8 per cent.

TABLE 5.—*Dissection of Culex quinquefasciatus (fatigans) mosquitoes after feeding on bird C35, positive for P. capistrani.*

Days after feeding.	Mosquitoes. Dissected.	With oöcysts.	With sporozoites.
8[a]	5	2	0
9	10	5	0
17	10	([b])	0
19	5	([b])	3
21	25	([b])	1
23	5	([b])	1
26	5	([b])	0
	19	([b])	3
28	2	([b])	0
29	26	([b])	1
30	26	([b])	2
Total	138	....	11

[a] Temperatures varied between 28° and 33° C. and the relative humidity between 85 and 96 during this period.

[b] No examination for oöcysts.

In Plates 1 and 3 are shown an oöcyst and sporozoites, respectively, of *P. capistrani* in *Culex quinquefasciatus*. The oöcyst was photographed nine and one-half days after a blood meal on C35. The temperature had varied in the meantime between 28° and 29.2° C., and the relative humidity between 85 and 96. Not enough oöcysts have been measured to give average sizes. The one photographed measured 38 and 43 μ in diameter. This is relatively large compared to the oöcysts of *P. cathemerium* and *P. relictum*.

The sporozoites were photographed twenty-four days after the mosquito had a blood meal from C35. Temperature had varied between 28.1° and 30.1° C. and relative humidity between 86 and 96 during this period. As noted in Table 5 the first sporozoites were found after nineteen days in mosquitoes infected with *P. capistrani*. Not enough dissections have been done to fix this development period exactly, but it would seem to be longer than the corresponding period in *P. cathemerium* and *P. relictum*.

Two negative birds, C47 and C48, were placed in a cage with these mosquitoes on each night from September 1 to 7, that is eleven to seventeen days after the mosquitoes had fed on C35. Blood smears from C47 were negative September 1 and 8, + September 9 and 10, negative September 11 and 12, + September 14, and negative September 15, 16, 17, 18, and 19. This bird died October 13.

Smears from C48 were negative September 1 and 8, were + September 9, 10, 11, and 12; + + + + September 14; + + + + + September 15, 16, 17, 18, 20, and 21. This bird died September 23.

In a similar way birds C71, C82, and C83 were infected by the bites of mosquitoes which had fed twenty-five days previously on C48. Bird C71 was exposed on one night only, October 12, and became + + + + + for *P. capistrani* October 26, dying October 31.

Birds C82 and C83 were exposed on one night only, October 15, to mosquitoes which had fed on C48 twenty-three days previously. Bird C82 was + October 27, 29, and 31. It was negative October 15, 24, 25, 26, and November 14. C83 was + October 25, 31, and November 14; + + October 27 and 29, negative October 15, 24, and November 2.

October 15, seventy-five mosquitoes, which had fed twenty-eight days previously on C48, were dissected, and the thorax of each insect was added to normal saline solution, the entire mixture being ground up as fine as possible. From this mixture 0.2 cubic centimeter each was injected into ten birds, C72 to C81. Three of these birds, C72, C76, and C79, died within a few days. Five of the remaining seven remained negative (two of these five with the help of chinoplasmin).. Two birds became infected, C73 and C78. Bird C73 was + October 29 and 30. It was negative October 15, 26, 28, November 1, 2, 3, 5, 6, and 9. This bird died November 11. Bird C78 was + November 1 and 2; + + + November 4; + + + + November 6; + + + + + November 7 and 9. Smears were negative October 15, 27, 29, and 31. This bird died November 9.

Plasmodium capistrani has, therefore, been transmitted in three ways—by direct needle inoculation of infected blood, by needle inoculation of sporozoites, and by the natural bite of infected culex mosquitoes.

CROSS INFECTIONS

It seems well substantiated that superinfection with a single species of avian malaria is not possible. While a bird is infected with one species these parasites confer "premunition" (10) to another infection with the same species. If inoculation be attempted with another species, however, superinfection usually takes place. Therefore, cross infections were attempted between *P. capistrani* and three other recognized species of avian malaria; namely, *P. elongatum*, *P. relictum*, and *P. cathemerium*.

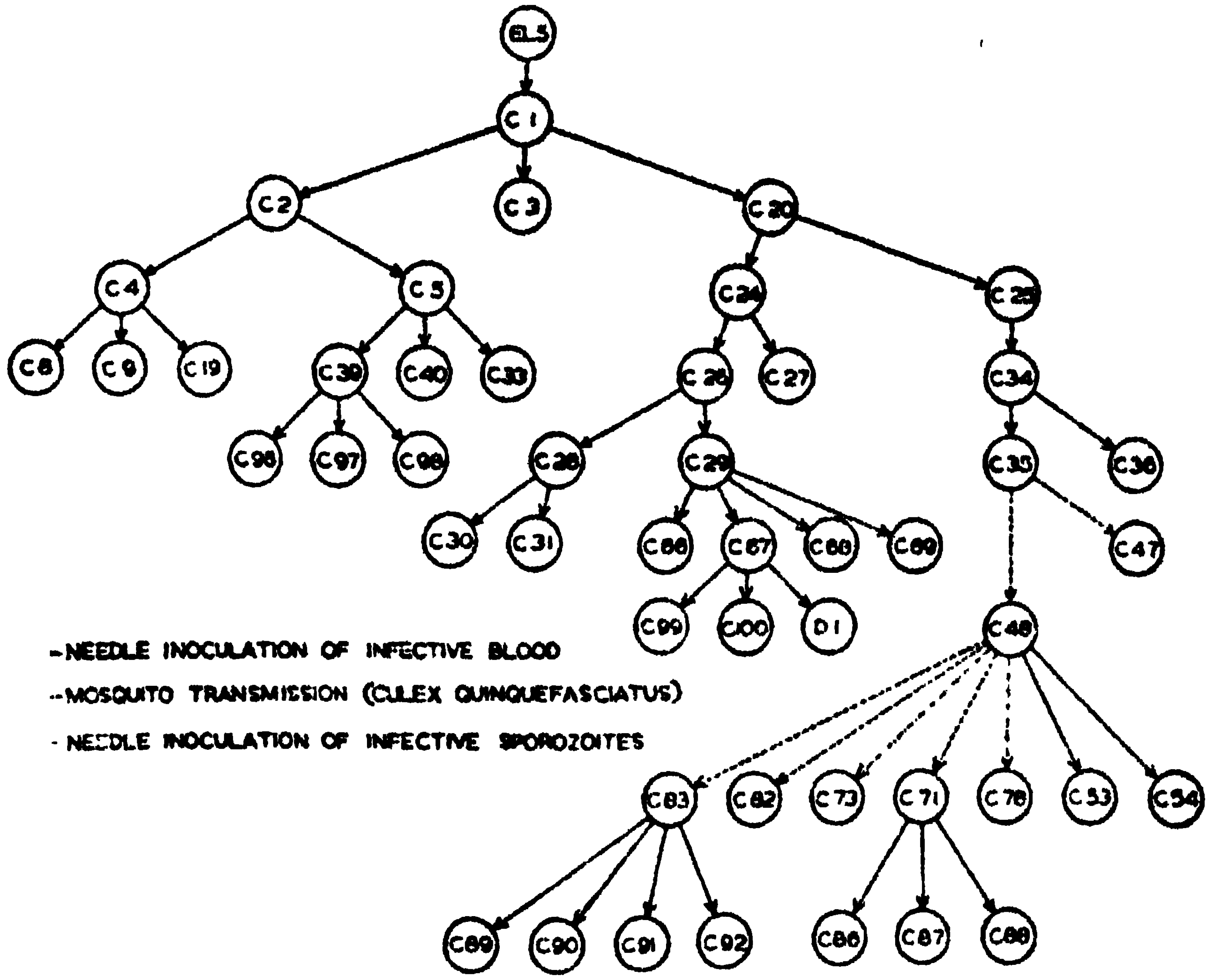

FIG. 1. Lines of transmission of *Plasmodium capistrani* sp. nov.

For these three parasites I am indebted to Dr. C. G. Huff from whom I received them in 1929. I have propagated them in canaries since that time. In previous papers (11, 12, 13) reporting experiments in which I used *P. cathemerium*, I have mistakenly referred to *P. cathemerium* as the Boston strain of Doctor Huff. It is probable that the Boston strain is *P. relictum*. The *P. relictum* used in the following cross infections comes from the original Whitmore strain. The *P. cathemerium* is descended from the original Hartman strain and the *P. elongatum* from the original Huff strain. They seem to have remained true to their specific characters.

Plasmodium capistrani has been successfully cross inoculated with all three of these plasmodia. In one series, birds with *P. capistrani* infections have been recipients of one or more of the other species. In another series birds having infections with the other species have received *P. capistrani* without evidence of premunition. Biologically, therefore, as well as morphologically, there seems reason to believe that *P. capistrani* is a valid species. There follow the protocols of the birds used in cross-infection experiments:

Bird L11.

This bird received intramuscularly an infective inoculum of blood-saline mixture from X38 April 18, 1931. Blood smears from L11 were negative April 18 and 28. They were positive for *P. cathemerium* April 29 and 30, were negative May 8 and 9, June 17, July 24, August 3, 4, and 5.

July 24 this bird (L11) received intramuscularly an infective inoculum of blood-saline mixture from C25, a bird whose blood, July 22, had been + for *P. capistrani* although negative July 24. Blood smears from L11 were + for *P. capistrani* August 6, 7, and 8, + + + August 10, + + + + + August 11 and 12, + + + + August 14, 15, 17, + + August 19 and 21. This bird was still alive November 15, 1931.

Bird L76.

This bird received intramuscularly an infective inoculum of blood-saline mixture from L62 June, 1931. Blood smear was negative June 1. Smears were + + + + June 8, 9, and 10 for *P. cathemerium*, + + June 11, 12, and 13, + June 15. September 16 this bird was subjected to the loss of 0.5 cubic centimeter of blood in some experimental studies on relapse. Yet in spite of this severe hæmorrhage and repeated thirty-minute examinations smears from L76 were negative September 16, 17, 18, 19, 21, 22, and 23. One parasite in thirty minutes was found September 24. Thereafter, blood smears were negative September 25, 26, 28, October 12, 16, 17, 18, 20, 21, 22, 23, 24, 27, 28, 29, and November 2.

October 12 this bird (L76) received intramuscularly an infective inoculum of blood-saline mixture from N61, a bird whose blood smear on this date was + for *P. cathemerium*. Yet, as noted in the preceding paragraph, blood smears remained negative. On the same date (October 12), however, blood from L76 was injected with N77, N78, and N79. Of these birds N77 and N79 had + blood smears October 21 and N78 October 23 and thereafter.

L76, therefore, still had a chronic infection with *P. cathemerium*, yet this could only be proved by the infectiveness of its blood. From this experience it may be concluded, parenthetically, that cases of spontaneous cure in avian malaria cannot be admitted without proof that the blood is no longer infective to a series of birds.

October 27 this bird (L76) received intramuscularly an infective inoculum of blood-saline mixture from C71, a bird whose blood smear that date was + + + + + for *P. capistrani*. Blood smears were + November 4, 5, 6, 7, 9, 10, 11, 12, and 14. This bird (L76) was still alive November 15.

Bird K5.

This bird received intramuscularly an infective inoculum of blood-saline mixture from K3 June 27, 1931. Blood smears were + for *P. elongatum* July 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and August 10. Smears were negative August 17 and 20.

August 10 this bird (K5) received intramuscularly an infective inoculum of blood-saline mixture from C25, a bird whose blood smear on this date was + for *P. capistrani*. Blood smears from K5 were + for *P. capistrani* August 18, 19, 21, 25; + + + August 27 and 29. This bird died September 10, 1931.

Bird 26RW.

This bird received intramuscularly an infective inoculum of blood-saline mixture from 20RW August 3, 1931. Blood smears were + for *P. relictum* August 14, 15, and 24. Smears were negative August 3, October 27, 28, 29, November 2, 4, 6, 7, and 14.

October 27 this bird (26RW) received intramuscularly an infective inoculum of blood-saline mixture from C71, a bird whose blood on this date was + + + + + for *P. capistrani.* Blood smears from 26 RW were + for *P. capistrani* November 10 and 12.

Bird 28RW.

This bird received intramuscularly an infective inoculum of blood-saline mixture from 20RW August 3, 1931. Blood smears were + for *P. relictum* August 14, 15, October 28, November 4 and 12. Smears were negative August 3, October 27, 29, and November 2.

November 10 this bird (28RW) received intramuscularly an infective inoculum of blood-saline mixture from C91, a bird whose blood on this date was + for *P. capistrani.* Blood smears from 28RW were + for *P. capistrani* November 21, 23, 24, and 25. They were entirely negative November 10 and 19.

Bird 34RW.

This bird received intramuscularly an infective inoculum of blood-saline mixture from 26RW August 24, 1931. Blood smears were + for *P. relictum* September 3, + + + + September 5. Smears were negative November 14.

November 14 this bird (34RW) received intramuscularly an infective inoculum of blood-saline mixture from C89, a bird whose blood was + + + + + for *P. capistrani.* Blood smears were negative November 20, 21, and 24. They were positive for *P. capistrani* November 23.

Bird C1.

This bird received intramuscularly an infective inoculum of blood-saline mixture from wild-caught bird EL5 (*Excalfactoria lineata*) August 4, 1930. Blood smears were negative August 4, 7, 8, 9, 11, 12, 13, and 14. Smears were positive for *P. capistrani* August 15, 16, 18, 19, and 20. Thereafter smears were negative August 21, 22, 28, September 16, 24, 27, October 22, January 2, 1931, February 10, March 10, 12, 16, 17, 18, 23, 27, 28, and 30.

March 23, 1931, this bird (C1) received intramuscularly an infective inoculum of blood-saline mixture from X64, a bird whose blood smear on this day was + for *P. cathemerium.* Blood smears from C1 were + for *P. cathemerium* March 31 and April 1 and 4. They were + + + + April 6 and + April 14, 21, 22, and 23.

April 14 this bird (C1) received intramuscularly an infective inoculum of blood-saline mixture from 18RW, a bird whose blood smear this day was + for *P. relictum.* Blood smears were + for *P. relictum* April 23, 24, 25, 28, and 29. Blood smears were entirely negative April 30.

April 29 this bird (C1) received intramuscularly an infective inoculum of blood-saline mixture from 88RE, a bird whose blood smear this day was + for *P. elongatum.* Blood smears from C1 were + for *P. elongatum* May 9, 11, and 18. They were entirely negative May 12. This bird died July 2, 1931.

C12.

This bird received intramuscularly an infective inoculum of blood-saline mixture from wild-caught bird EL28 (*Excalfactoria lineata*) November 7, 1930. Blood smears were negative November 7, 14, 15, 17, 18, 19, 20, 21, and 22. Smears were positive for *P. capistrani* November 24, 25, and 26. Thereafter smears were negative November 28, December 2 and 4, January 2, March 10, 12, 16, 17, and 18, and April 8, 14, and 16.

April 8 this bird (C12) received intramuscularly an infective inoculum of blood-saline mixture from 13RW, a bird whose blood smear this day was + for *P. relictum*. Blood smears from C12 were + for *P. relictum* April 18, 20, 22, 25, 28, 29.

April 29 this bird (C12) received intramuscularly an infective inoculum of blood-saline mixture from 88RE, a bird whose blood smears this day were + for *P. elongatum*. Blood smears from C12 were positive for *P. elongatum* May 9, 11, and 12. The bird, C12, died May 13, 1931.

Bird C13.

This bird received intramuscularly an infective inoculum of blood-saline mixture from wild-caught bird EL28 (*Excalfactoria lineata*) November 7, 1930. Blood smears were negative November 7, 14, 15, 17, and 18. Smears were + for *P. capistrani* November 19, 20, and 21.

Thereafter smears were negative November 22, 24, 25, 26, and 28, December 2 and 4, January 2, February 10, March 10, 12, 16, 17, and 18, and July 8.

July 8 this bird (C13) received intramuscularly an infective inoculum of blood-saline mixture from 20RW, a bird whose blood smear this day was + for *P. relictum*. Blood smears from C13 were + for *P. relictum* July 18, 20, and 21. They were + + July 22 and 23, and + July 24, 25, and August 10. This bird died August 13, 1931.

Bird C24.

This bird received intramuscularly an infective inoculum of blood-saline mixture from bird C20 April 8, 1931. Blood smears were negative April 8, 14, 16, and 18. They were + for *P. capistrani* April 20, 21, 22, and 25.

July 8 this bird (C24) received intramuscularly an infective inoculum of blood-saline mixture from 20RW, a bird whose blood smear this day was + for *P. relictum*. Blood smear from C24 was + for *P. relictum* July 18. The bird died July 20.

Bird C25.

This bird received intramuscularly an infective inoculum of blood-saline mixture from bird C20 April 8, 1931. Blood smears were negative April 8, 14, and 16. They were + for *P. capistrani* April 18 and 22, July 8, 14, 16, and 22, and August 10. They were negative July 25 and August 24.

August 10 this bird (C25) received intramuscularly an infective inoculum of blood-saline mixture from K5, a bird whose blood smear this day was + for *P. elongatum*. Blood smears from C25 were + for *P. elongatum* August 10, 19, 20, 21, and 22. This bird died August 30, 1931.

C30.

This bird received intramuscularly an infective inoculum of blood-saline mixture from C28 June 1, 1931. Blood smears were negative June 1, 8,

and 9. They were positive for *P. capistrani* June 11, 13, and 20; negative June 15, 17, and 18.

June 18 this bird (C30) received intramuscularly an infective inoculum of blood-saline mixture from L90, a bird whose blood smear this date was + + + + for *P. cathemerium*. Smears from C30 were + for *P. cathemerium* June 22, 23, and 24, + + June 25, + + + + June 26, and + + + + + June 27. This bird died June 28, 1931.

Bird C44.

This bird received intramuscularly an infective inoculum of blood-saline mixture from bird C42 August 22, 1931. C42 had been infected with a parasite obtained from a wild-caught bird—*Turnix fasciata*—through the following passages: July 31, 1931, *Turnix fasciata* to C37. August 15, 1931, C37 to C42.

This parasite was probably *P. elongatum*, as it resembled this species morphologically and could not be transmitted to birds with known *P. elongatum* infections. Bird C44, therefore, was probably infected with a local strain of *P. elongatum*.

Blood smears from C44 were negative August 22, 27, and 29. They were positive August 31, September 2, 4, and 7. These smears contained elongate gametocytes. Blood smears were negative September 24, 26, 28, and 29, and October 1.

September 26 this bird (C44) received intramuscularly an infective inoculum of blood-saline mixture from C40, a bird whose blood smear this day was + for *P. capistrani* sp. nov. Blood smears from C44 were + for *P. capistrani* October 3, 5, 6, and 7; + + October 8; + + + + October 9. This bird was alive November 15.

Bird C68.

This bird received intramuscularly an infective inoculum of blood-saline mixture from C29 September 26. Blood smears from C68 were negative September 26 and October 5. They were positive for *P. capistrani* October 6 and 7, + + + October 13, 15, 17 and 20, negative October 24.

November 14 this bird (C68) received intramuscularly an infective inoculum of blood-saline mixture from 34RW, a bird whose blood smear had been + + + + for *P. relictum* September 5 but was negative November 14. Blood smears were negative November 19, 20, 21, 23, 24, 25, and 27 but were + for *P. relictum* November 28 and December 1.

SUMMARY

The discovery is reported of a new plasmodium of avian malaria which it is proposed to call *Plasmodium capistrani*.

Descriptions and drawings are given of this parasite in its various phases. Mosquito transmission is reported and also cross-infection experiments with three common species of avian malaria plasmodia.

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ILLUSTRATIONS

PLATE 1

FIGS. 1 to 8. *Plasmodium capistrani* sp. nov. *1* and *2*, Young trophozoites; *3* and *4*, older asexual forms; *5* and *6*, segmenting forms; *7*, microgametocyte; *8*, macrogametocyte.

9 to 11. *Hæmoproteus* from *Aluco longimembris*.

12 to 14. *Hæmoproteus* from *Excalfactoria lineata*.

FIG. 15. *Plasmodium elongatum* Huff, 1930. from *Turnix fasciata*.

All figures in Plate 1 are × 3,000.

PLATE 2

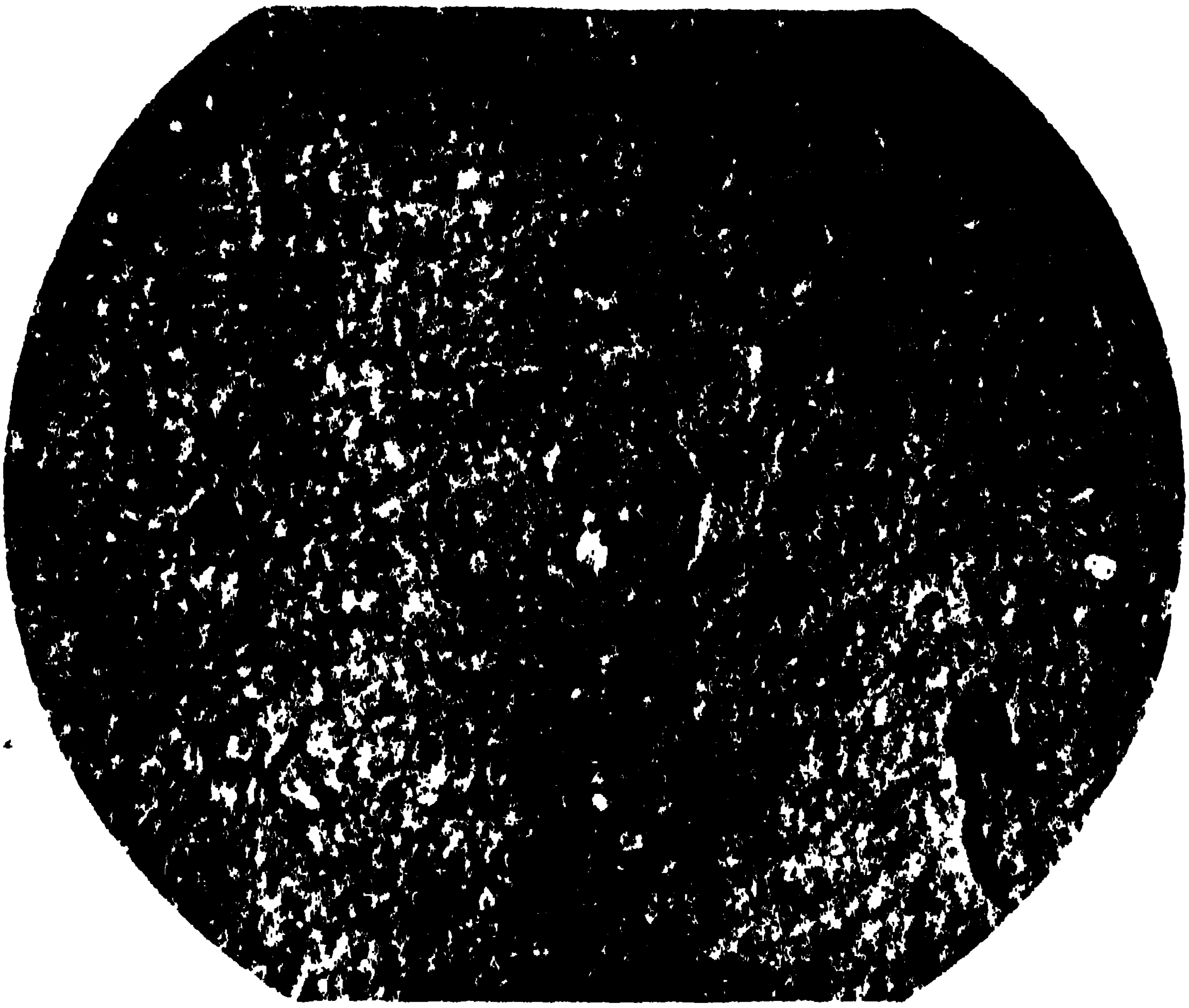
FIG. 1. Oöcyst of *Plasmodium capistrani* sp. nov. on stomach wall of *Culex quinquefasciatus*; diameters 38 × 43 μ. (Photograph by the Bureau of Science.)

2. Sporozoites of *Plasmodium capistrani* sp. nov. near ruptured salivary gland of *Culex quinquefasciatus*; × 500. (Photograph by the Bureau of Science.)

TEXT FIGURE

FIG. 1. Lines of transmission of *Plasmodium capistrani* sp. nov.

PLATE 1.



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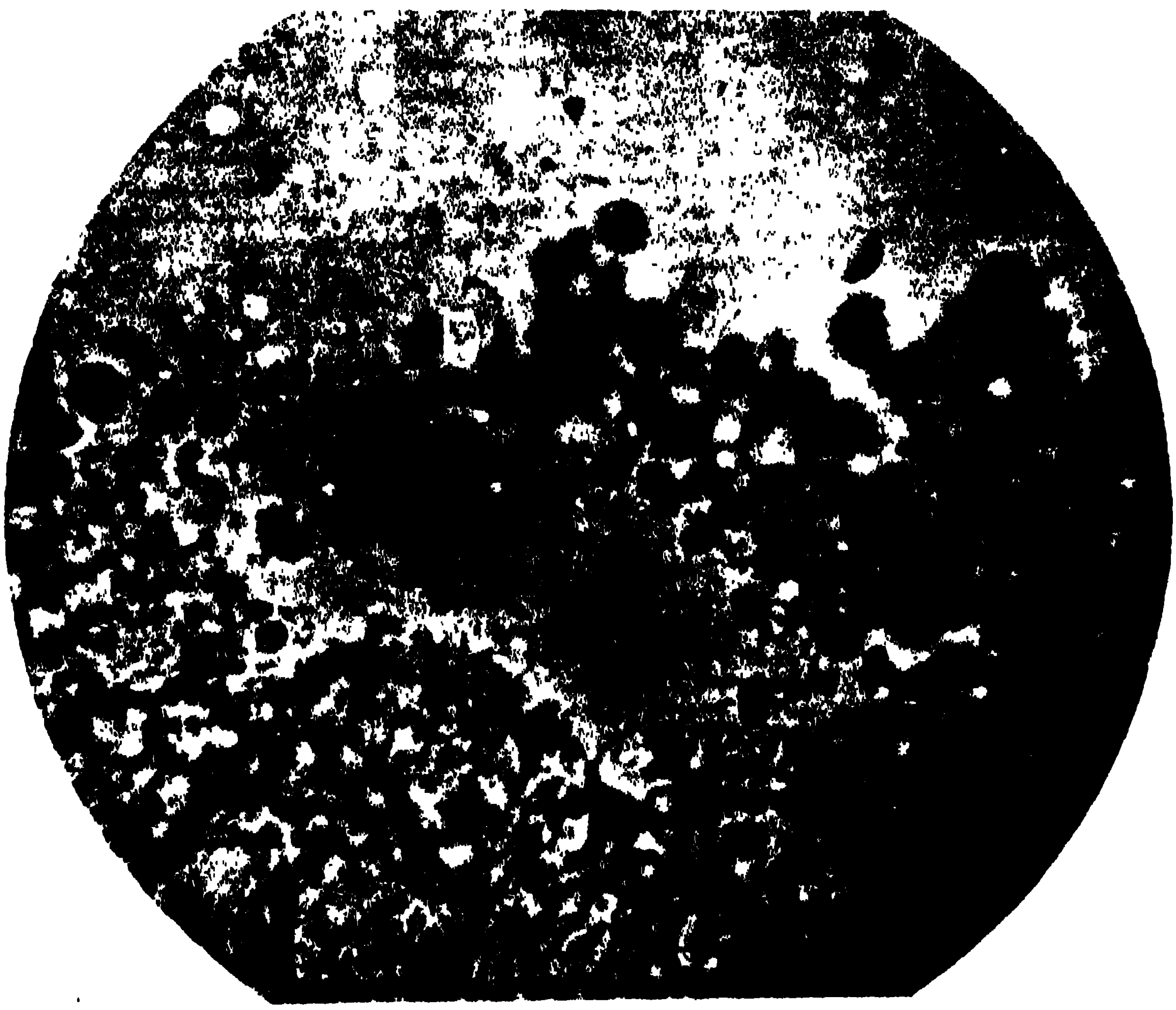

PLATE 2.

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CHARCOAL AS A DILUENT FOR PARIS GREEN IN THE DESTRUCTION OF ANOPHELES LARVÆ

LARVICIDE STUDIES [1]

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ONE PLATE

Dust sprays as mosquito larvicides have now been in use for some years. A very common spray which has been employed considerably consists of road dust containing 1 per cent of Paris green. In place of road dust other substances have been mixed with Paris green and used as diluents. Recently we have experimented with powdered wood charcoal. We have found that a dust spray of wood charcoal with 1 per cent Paris green kills over 80 per cent of larvæ in four hours. A spray with a concentration of only 0.2 per cent Paris green in charcoal killed over 80 per cent in six hours. Both of these charcoal sprays killed all the larvæ in twenty-four hours. From our experiments it would appear that wood charcoal is an excellent diluent for dust sprays intended for mosquito larvicides.

[1] These studies were undertaken by the divisions of organic chemistry and of malaria investigations, Bureau of Science. The division of malaria investigations is coöperatively supported by the bureau and by the International Health Division of the Rockefeller Foundation.

Since Roubaud[2] in 1920 advocated the use of dry powdered para-formaldehyde (trioxymethylene) to poison mosquito larvæ, and Barber and Hayne,[3] in 1921, first reported the efficacy of Paris green in destroying anopheles larvæ there has been an ever increasing interest in dust larvicides. Paris green in particular has had a great deal of experimental study and a wide practical use as a weapon against larvæ of anopheles mosquitoes. Covell[4] gives an excellent bibliography covering this field up to 1931.

PARIS GREEN

According to Bourcart[5] arsenical insecticides have been used since 1859. He states that Le Baron in 1872 recommended the use of Paris green against the caterpillar of the citigrade spider. Since that time its use has spread widely until now it is sold in enormous quantities throughout the world. When used as a powder, it is frequently in the manner suggested by Bourcart. A mixture of 1 part Paris green to 100 parts of very finely divided gypsum, ashes, or similar substance is spread with the wind over the habitat of the insect, which eats the Paris green and dies of arsenic poisoning.

The Paris green used to-day by health officers as an anopheles larvicide is the commercial copper-acetoarsenite, having between 50 and 55 per cent arsenious oxide. It is a double salt of copper acetate and copper metaarsenite and when pure has the formula $3Cu(AsO_2)_2.(CH_3COO)_2Cu$. It is difficultly soluble in water. The powder should be fine enough to pass a 200-mesh bolting cloth. It may be obtained in qualities that will (*a*) sink rapidly in water; (*b*) float a short time; or (*c*) float for some hours on the surface of water. To be of any value in the destruction of anopheles larvæ Paris green must meet certain conditions:

1. The particles of Paris green must be small enough to be ingested by the larvæ and potent enough to poison them.

2. The particles must be made available to the larvæ. This requires:

(*a*) Distribution to all parts of the breeding area, even among thick water grasses and dense aquatic vegetation.

[2] C. R. Acad. Sci. 60 (1920) 1521.

[3] U. S. Pub. Health Rpts. 36 (1921) 3027.

[4] Malaria Control by Anti-Mosquito Measures (1931) 122.

[5] Insecticides, Fungicides and Weedkillers (1913) 270.

(*b*) Flotation on the surface of the water long enough for the anopheles larvæ—all of which feed at the surface—to accomplish ingestion.

3. The Paris green must not be of any danger to fishes, aquatic birds, domestic or wild animals, or to humans who may chance to use the water in question for washing, bathing, or drinking purposes.

These conditions have been met as noted above, by diluting finely powdered Paris green with some equally finely divided innocuous material and sowing this mixture, down the wind, over a breeding place. To throw the mixture over the water there has been a wide variety of devices, from hand-blowers to airplane distributors.

PARIS GREEN DILUENTS

There have been tried and recommended many diluents for Paris green, in various parts of the world. Among them are the following which are used in powdered form:

Ashes; for example, of wood or rice stalks.
Brick dust.
Cement dust.
China clay.
Coconut husks.
Coir dust.
Cork dust.
Flour (spoiled).
French chalk.
Gypsum.
Limestone.
Pollen.
Road dust.
Sand, fine.
Sawdust.
Silt, dried.
Soapstone.
Soils, various, dry and sifted.
Sulphur.
Wood dust, rotting.

CHARCOAL

The purpose of this paper is to call attention to the usefulness of wood charcoal as a diluent for Paris green. Naturally the choice of a diluting substance must depend to a large extent on the local conditions of supply. In some places charcoal would be ruled out by excessive cost. But in many localities, as in the Philippines, powdered charcoal may be used to advantage. Here road dust is not always easily taken and during the rainy season is unobtainable. It is also heavier than desirable for dusting purposes. Powdered rice-stalk ashes are more readily obtained but are relatively heavy and sink rapidly, carrying some of the Paris green with them. Lime has about the same cost as charcoal but, as elsewhere, it is prepared with difficulty. It is a most disagreeable substance to dry, to powder, and to spread,

but it has the advantage of being visible for some time after dusting. This affords a ready means for checking up the labor factor. Road dust and many similar dusts do not have this quality of visibility after application.

Charcoal is readily obtainable, is easily prepared, floats longer than Paris green (see illustrations), is visible after application, is easily distributed, and is not expensive.

Locally the cost of charcoal suitable for powdering is 1 peso for 80 kilos, or 0.0125 peso per kilo (approximately 0.003 dollar per pound). It may be pulverized at reasonable cost. In the field, for example, an unskilled laborer, with a primitive rice-pounding outfit ("mortar and pestle") can powder and sift more than 100 kilos (220 pounds approximately) of charcoal powder per day, at a cost of from 0.50 to 1.00 peso (0.25 to 0.50 dollar) (see illustrations). The total cost is therefore approximately 0.0225 peso per kilo (0.005 dollar per pound). Charcoal varies in weight so that the volume of 100 kilos when powdered varies. Tentatively, it may be said that the total cost of the charcoal including powdering, sifting, and mixing, is about 0.08 peso per liter.

Old rice mills may be utilized for powdering or, if the demand be sufficient, modern grinders could deliver the powder economically.

The usual dilution of Paris green may be used. For ordinary purposes, 1 part Paris green to 99 parts charcoal by volume, is effective, using Hackett's[6] plan of allowing 0.1 cubic centimeter (0.125 gram or 1.9 grains) of Paris green to the square meter of surface. The dilution should, of course, be modified to meet local conditions, and methods of application, always with an eye to avoiding the danger of poisoning other life than mosquito larvæ. A liter of mixture, costing altogether about 0.09 peso is sufficient to treat 100 square meters of surface or along 100 meters of bank.

In Table 1 are given the results of some laboratory experiments with Paris green and lime, Paris green and rice ashes, and Paris green and charcoal mixtures. They seem to be about equally effective in these laboratory tests.

[6] Trans. 1st Internat. Congress Mal. Rome (1925) 158.

TABLE 1.—*Some laboratory experiments with lime-Paris green and charcoal-Paris green mixtures in destroying anopheles larvæ.*[1]

Test No.	Substances used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time periods. Cumulative totals. Minutes. 15	30	45	60	75	90	105	120	Hours. 2.5	3	4	5	6	7	24	Amount of mixture.
		Per cent.																	g.
79	Nothing (control)		50	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
141	....do.		50	0	0	0	0	0	0	0	0	0	0	0	2	2	2	6	
78	Paris green and lime	1	50	0	0	0	0	4	6	14	32	42	60	82	88			100	0.1
82	....do.	1	50	0	2	2	4	4	14	42	48	62	72	88	92	94	94	94	0.1
113	....do.	1	50	0	0	0	0	0	2	12	22	34	94	96	96	98	98	100	0.1
86	Paris green and charcoal	1	50	0	0	0	2	2	10	20	30	70	78	92	100	100	100	100	0.1
146	....do.	1	50	0	0	0	0	0	2	2	4	4	90	94	94			100	0.1
139	....do.	0.2	50	0	0	0	0	0	2	2	2	10	18	60	78	84		100	0.33
183	....do.	1	50	0	0	0	10	32	48	58	62	70	74	82	98	98	98	100	0.3
176	Paris green and rice ashes	1	50	0	2	10	34	56	72	72	72	82	86	90	92	94	96	100	0.3

[1] In these experiments the larvæ were third- and fourth-stage *A. subpictus* and *A. hyrcanus* var. *sinensis*. Enamel pans were used, the water in the pans having a surface area of 532 square centimeters and a depth of 5 centimeters. Larvæ were not pronounced dead until all motion had ceased. They were then removed to separate beakers of water to guard against possible mistakes in diagnosis or counting. The amount of mixture used was less per area than that advocated for field use. Control pans were used with the same number and species of larvæ, same water and external influences.

SUMMARY

Results of our experiments indicate that powdered wood charcoal is an excellent diluent for dust sprays intended as anopheles mosquito larvicides. Charcoal would appear to be an appropriate diluent especially in localities, like the Philippines, where it is very cheap.

Compared with other diluents charcoal has certain decided advantages, such as the property of floating easily, visibility, etc.

Dust sprays of charcoal with low concentrations of Paris green have given excellent results in the laboratory.

ILLUSTRATION

PLATE 1

FIG. 1. Charcoal floating on water.
2. Pulverizing charcoal in the field.
3. Rice-pounding outfit used for charcoal.

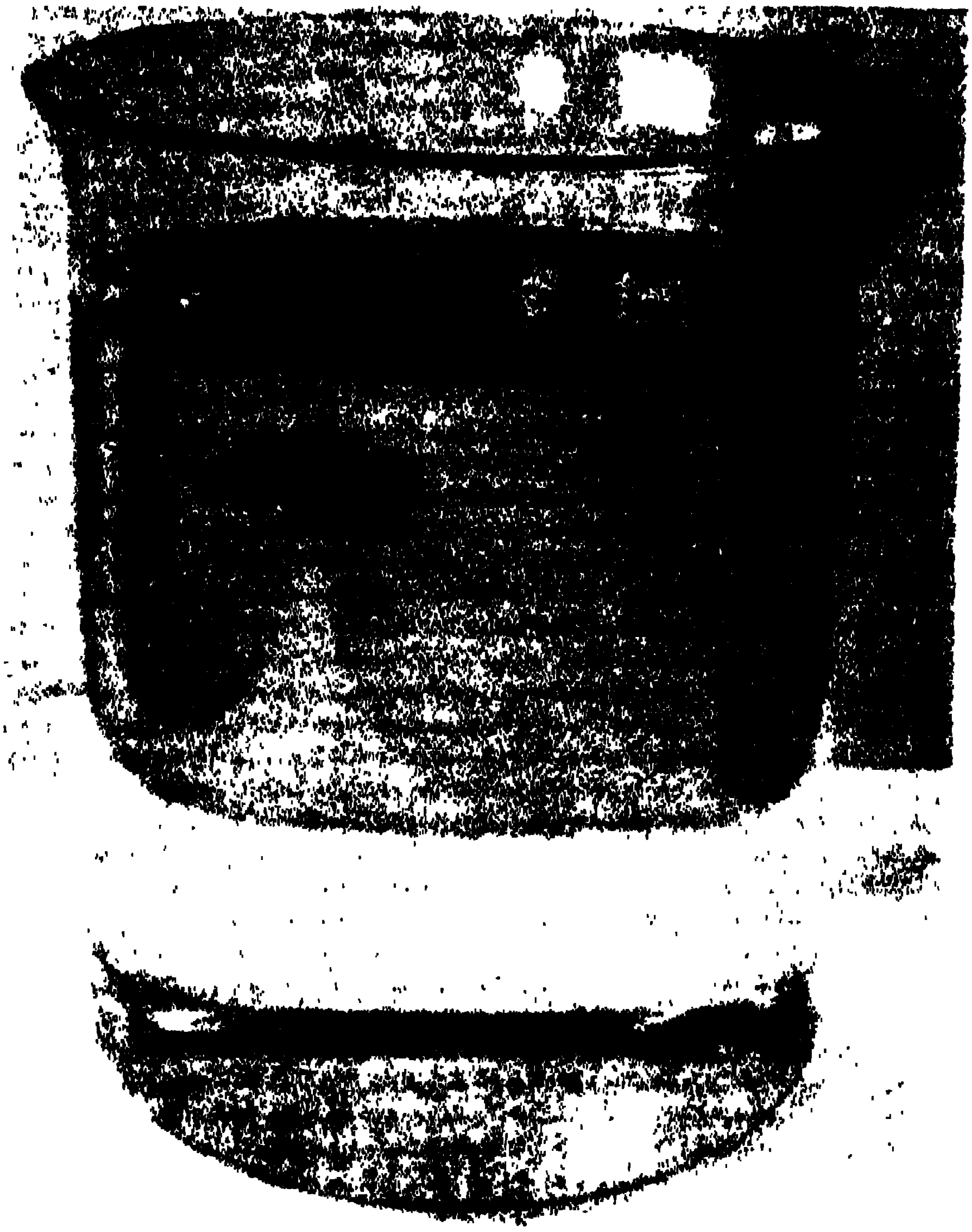

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PLATE 1.

COMPOSITION OF PHILIPPINE WOODS, III

BALOBO, ALUPÁG, BANAI-BANAI, DULIT, AND PINE

By Luz Baens, F. M. Yenko, and Augustus P. West

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and

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TWO PLATES

This paper is a continuation of our work on the composition of Philippine woods.[1] It is estimated that the virgin forests of the Philippines cover about 40,000 square miles and there are more than 2,500 species of trees. We began this investigation with the intention of determining the composition of the more abundant species of trees. Realizing that a survey of this kind would require a considerable length of time we decided to publish our results from time to time as the various stages of the investigation are completed. This will make our results available at a much earlier date than if we waited until the entire work is finished.

At the various saw mills in the Philippines sawdust and scrap wood accumulate in considerable quantities. Although this material has a certain value as fuel it is possible that sawdust from certain species of woods contains constituents which make it more valuable for purposes other than fuel. For instance certain woods, or the sawdust from them, may possibly be suitable for the manufacture of rayon pulp. For industries which use wood as their basic raw material the composition of woods is a matter of considerable importance.

The Philippine woods we have analyzed in this investigation have the common names balobo, pine, alupág, banai-banai, and dulit. An account of the general properties of these woods is

[1] Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281 and 343.

given by Schneider.[3] A brief description of the woods is as follows:

Alupág (*Euphoria cinerea* Radlk.) is a small to medium-sized tree which reaches a diameter of 60 centimeters. The wood is very hard and heavy with a texture that is very fine, dense, and smooth. This wood seasons well, is difficult to work but takes a beautiful surface under sharp tools. It has the durability of 1 and is very rarely attacked by insects. It is used for posts, beams, flooring, and agricultural implements. Although this wood is widely distributed in the Philippines the supply is rather scarce.

Banai-banai (*Radermachera pinnata* Seem) is a small to medium-sized tree, with a maximum diameter of 80 centimeters. The wood is light and soft and very easy to work. The durability when exposed is probably poor, but it is not attacked by beetles. It is used in sculpture work and carving. It is also employed for making household implements and as a pretty cabinet wood for all sorts of light work. This wood is rather scarce.

Benguet pine (*Pinus insularis* Endl.) is a moderately tall, straight tree which sometimes reaches a diameter of 140 centimeters. The wood is soft to moderately hard, and is moderately heavy to very heavy. The heartwood is very resinous and rarely, if ever, is attacked by insects. Even termites avoid the heartwood and resinous knots. The heartwood seasons well and is easy to work, except for gumming the tools. The durability is very good. In the mountain regions where the pine is very abundant it is used for all kinds of purposes.

Balobo (*Diplodiscus paniculatus* Turcz.) is a small to medium-sized tree which may reach a height of about 25 meters and a diameter of about 60 centimeters. As it grows in the forest it is usually prominently buttressed. It has a spreading crown and few branches. This tree which is one of the commonest species is inclined to grow gregariously in low and medium altitudes in nearly all parts of the Philippines. The wood is fairly hard and may be used for general construction work.

Dulit (*Canarium multipinatum* Llanos) is a medium- to large-sized forest tree which may reach a height of about 28 meters and a diameter of about 80 centimeters. This is a fairly common tree in primary forest at low and medium altitudes from

[3] Bull. P. I. Bur. Forestry 14 (1916).

Luzon to Mindanao. The wood is fairly hard and may be used for general construction work.

In Table 1 are given the measurements of the trees from which samples were taken for our analyses.

In analyzing the wood samples we followed, in general, the methods adopted by the forest products laboratory at Madison, Wisconsin.[3] Certain details in the analytical procedures[4] which we found by previous experience to increase the accuracy of the results were also used.

TABLE 1.—*Measurements of Philippine trees used for wood analysis.*

Measurements.	Balobo.	Pine (thick bark).	Pine (thin bark).	Alupag.	Banai-banai.	Dulit.
Diameter, at breast height ..... cm	34.00	36.00	27.00	27.00	27.00	23.00
Total height..... m	17.00	....	....	18.00	17.70	15.00
Clear length of trunk. m.	9.00	....	....	8.00	10.00	12.00
Cut above ground ..... m.	3.88	....	....	2.13	2.05	2.30

TABLE 2.—*Analysis of Philippine woods.*

[The percentages were calculated on a moisture-free basis.]

Constituent.	Balobo.	Pine tree (thick bark).	Pine tree (thin bark).	Alupag.	Banai-banai.	Dulit.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10.03	10.77	10.04	2.19	2.39	2.97
Cold-water soluble	4.45	3.61	3.82	1.67	5.77	1.96
Hot-water soluble.....	5.01	7.18	6.87	3.02	7.09	7.98
Alkali soluble	10.71	9.75	10.40	13.75	14.43	19.82
Ether extract	0.52	2.27	4.69	0.15	0.93	0.28
Alcohol extract.....	1.96	2.29	1.22	2.39	4.84	1.05
Ash	3.43	0.48	0.53	1.40	0.79	1.63
Nitrogen	0.30	0.17	0.19	0.27	0.25	0.29
Cellulose	48.39	55.12	53.60	49.93	45.60	58.39
Ash in cellulose	0.40	0.36	0.33	0.02	0.08	1.03
Ash-free cellulose.....	47.99	54.76	53.27	49.91	45.52	57.36
Lignin.....	33.33	29.50	28.38	35.77	37.72	24.15
Alpha cellulose.....	79.73	68.76	70.63	68.62	74.79	76.90

[3] Bray, M. W., Paper Trade Journ. 87, No. 25 (1928) 59. Schorger, A. W., Chemistry of Cellulose and Wood (1926) 505.

[4] Yenko, F. M., Luz Baens, Augustus P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 343.

RESULTS

The results of analyzing the woods recorded in this paper are given in Table 2.

As shown by the data the Philippine woods gave a fairly high content of alpha cellulose.

Dr. E. Quisumbing, of the Bureau of Science, recognizes three kinds of Benguet pine trees; namely, those with thick, deep-furrowed bark, those with thin, smooth bark, and those with bark about intermediate between these two extremes. To ascertain if there was any difference in the composition of wood obtained from these different pines, we analyzed wood samples from the thick- and thin-bark trees. Our results indicate that wood from these different pines has approximately the same composition.

SUMMARY

Six samples of wood from Philippine trees were analyzed in this investigation. These woods have the common names balobo, alupag, banai-banai, dulit, pine (thick bark), and pine (thin bark).

These woods have a fairly high content of alpha cellulose.

Wood samples from pine trees of thick and thin bark gave approximately the same composition.

ILLUSTRATIONS

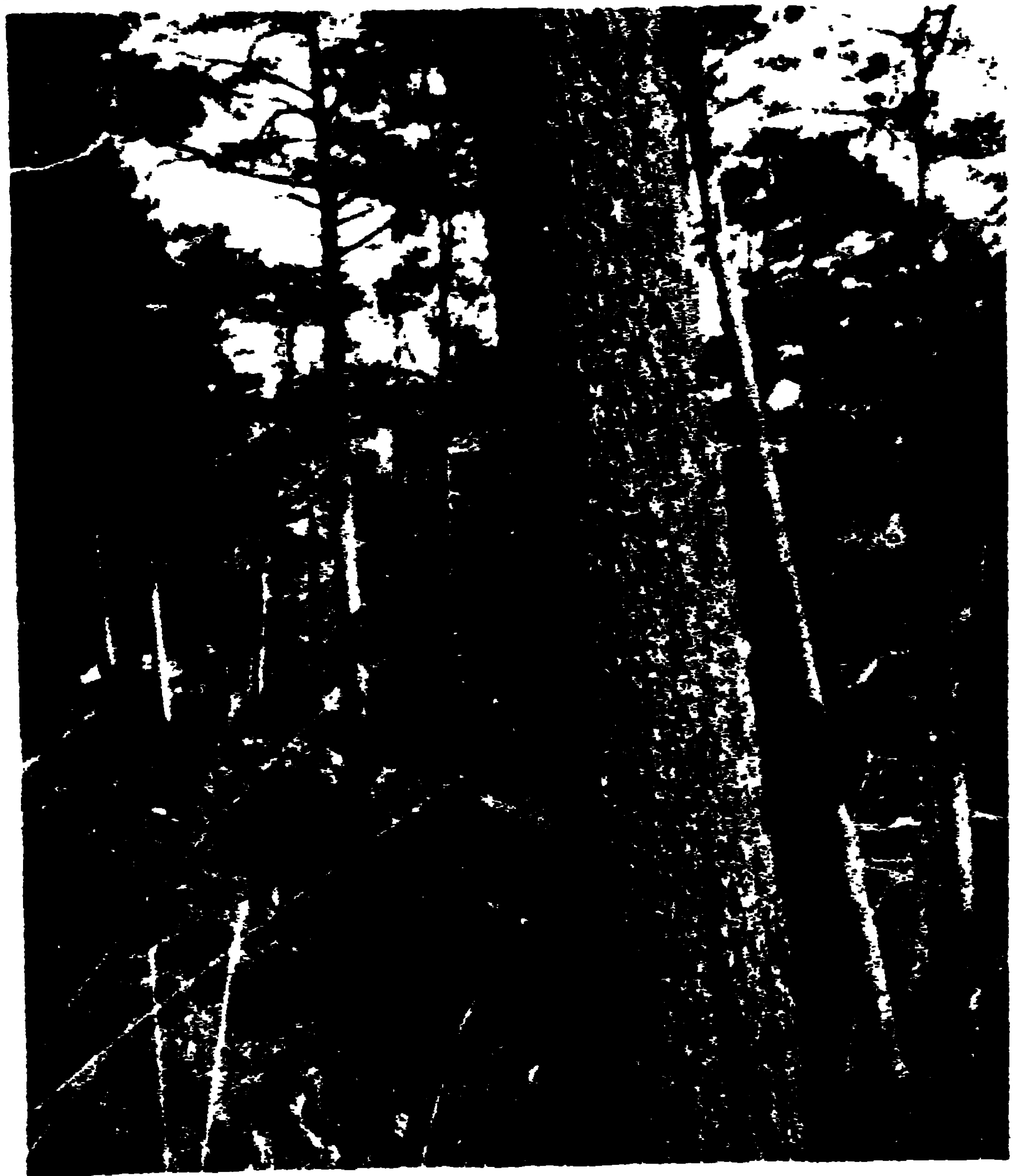

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PLATE

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PLATE 2.

DIE ALLECULIDEN-FAUNA DER PHILIPPINEN

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Auch diese Arbeit stützt sich in der Hauptsache, wie meine "Lagriiden-Fauna der Philippinen," auf das von dem verstorbenen Prof. Charles Fuller Baker gesammelte Material. Ein anderer, geringerer Teil stammt aus den Vorräten, die Herr G. Böttcher zusammengebracht hat. Einige wenige Tiere stammen von Herrn W. Schultze in Bad Tölz. Alle Typen der neuen Arten befinden sich in meiner Sammlung, wenn nichts anderes bemerkt ist. Dem Wunsche des Prof. Baker gemäss sind auch die von ihm in Borneo gesammelten Tiere mit beschrieben worden.

Das Material ist verhältnismässig gering wohl, weil die Vertreter der Familie fast alle recht unscheinbar sind, unter Rinden, in Pilzen, im Baummulme leben und zumeist, ihrer düsteren Färbung entsprechend, ein nächtliches Leben führen.

Über den Charakter der Fauna lässt sich nach dem vorliegenden Material ausser dem in meiner schon erwähnten Arbeit nicht viel Neues sagen. Zwischen der Fauna der Philippinen und der Insel Borneo besteht ein naher Zusammenhang. Beide Inselgruppen haben eine ganze Anzahl Arten und besonders Gattungen gemeinsam. Diese Beziehungen reichen sogar bis Sumatra hinüber, wie die von Borneo beschriebene *Allecula minuta* Pic, die sich auf Sumatra und den Philippinen wiederfindet, beweist. Bei fortschreitender Kenntnis wird sich gewiss die Zahl dieser Tiere ansehnlich vermehren.

Als einzige endemische Gattung habe ich *Cteisodes* vorgefunden. Auch in der vorliegenden Familie finden sich afrikanische Anklänge. Die neue Gattung *Cistelodema* ist der afrikanischen *Ectenostoma* ausserordentlich nahe verwandt.

Bisher waren von den Philippinen nur die drei Gattungen *Allecula, Cistelopsis,* und *Cistelomorpha* mit zusammen zwölf Arten bekannt.

Allecula minuta PIC, Mél. exot.-ent. 12 (1915) 14. Sumatra, Borneo, Philippinen.
Syn. *contempta* BORCHM., Ent. Mitt. 17 (1928) 408.

Allecula sericans FAIRM., Ann. Soc. Ent. Fr. VI 6 (1886) 190. Manila.—BORCHM., Philip. Journ. Sci. § D 8 (1913) 57. Luzon.

Cistelopsis ferruginea PIC, Mél. exot.-ent. 55 (1930) 24. Palawan.
Cistelopsis palawana PIC, Mél. exot.-ent. 55 (1930) 24. Palawan.
Cistelomorpha anæmatica BORCHM., Philip. Journ. Sci. § D 8 (1913) 59. Luzon, Butuan.
Cistelomorpha atricollis PIC, Bull. Soc. Ent. Fr. (1924) 230. Luzon.
Cistelomorpha brevehirsuta PIC, Mél. exot.-ent. 41 (1924) 32. Manila.
Cistelomorpha brunneolineata PIC, Mél. exot.-ent. 41 (1924) 32. Manila.
Cistelomorpha distinticornis PIC, Echange (1908) 48, 61. Philippinen.
Cistelomorpha rufiventris BORCHM., Philip. Journ. Sci. § D 8 (1913) 60. Insel Sibay.
Cistelomorpha semipellita BORCHM., Philip. Journ. Sci. § D 8 (1913) 57. Luzon, Benguet.
Cistelodema cyanea PIC, Mél. exot.-ent. 55 (1930) 29 (*Pseudocistela*). Mindanao.

Hinzu kommen die folgenden neuen Gattungen: *Cteisodes* mit 1 Art, *Stilbocistela* g. nov. mit 1 Art, *Ommatochara* mit 5 Arten, und *Cistelodema* mit 1 Art.

Von *Allecula* wurden 9, von *Cistelopsis* ebenfalls 9, von *Cistelomorpha* ebenso 9 neue Arten, also im Ganzen 46 Arten festgestellt.

Es ist mir nicht unbewusst, dass die beigegebenen Tabellen nicht allen Anforderungen restlos entsprechen; aber ihre Verbesserung muss späteren Zeiten überlassen werden, wenn gründlichere Kenntnisse sie möglich machen.

Bei den Beschreibungen der neuen Arten habe ich alle entbehrlichen Angaben weggelassen. Wenn irgend ein Körperteil unerwähnt bleibt oder als "normal" oder "gewöhnlich" bezeichnet wird, stimmen seine Eigenschaften mit den in der Gattungsbeschreibung gegebenen überein.

Gattungen.

1 (16) Mandibeln zweispitzig.
2 (15) Wenigstens das vorletzte Tarsenglied aller Füsse unten lappig erweitert.
3 (14) Das Endglied der Kiefertaster ist nicht auffallend breit oder abweichend gestaltet, innere Ecke nicht umgeschlagen.
4 (13) Augen nicht auffallend gestaltet, nicht auf einer Erhöhung stehend.
5 (10) Körper kurz, oval.
6 (7) Halsschild vorn stärker gewölbt, quer viereckig, mit abgerundeten Vorderecken; Vorderrand breit ausgeschnitten, Vorderecken nicht verrundet; Punktstreifen sehr fein, Punkte der Zwischenräume noch feiner .... ***Cteisodes* g. nov.**

7 (6) Halsschild vorn nicht erkennbar stärker gewölbt.
8 (9) Punkte auf den Zwischenräumen meistens so gross wie die Punkte in den Streifen; Halsschild am Vorderrande gerundet. *Cistelopsis* Fairm.
9 (8) Punkte auf sehr breiten den Zwischenräumen sehr fein, Halsschild vorn nicht gleichmässig gerundet, sondern breit und flach ausgerandet .... *Stilbocistela* g. nov.
10 (5) Körper gestreckt; Halsschild nicht mit scharfen Kanten, nur fein gerandet.
11 (12) Endglied der Lippentaster nicht ausgerandet.... *Allecula* Fairm.
12 (11) Endglied der Lippentaster vorn ausgerandet.... *Alleculodes* Borchm.
13 (4) Augen sehr stark quer, schräge, auf einer Erhöhung stehend, weil die Schläfen senkrecht stehen; Halsschild viereckig, mit abgerundeten Vorderecken .... *Ommatochara* g. nov.
14 (3) Endglied der Kiefertaster auffallend breit, innere Ecke umgeschlagen (wenigstens beim Männchen) . . *Palpichara* g. nov.
15 (2) Alle Tarsenglieder ungelappt, Glieder fast drehrund.
16 (1) Mandibeln einspitzig.
17 (18) Fühler fadenförmig, niemals stark abgeplattet; Kopf stark gestreckt; Käfer ganz oder vorherrschend gelb; Punktstreifen kräftig .... *Cistelomorpha* Redtb.
18 (17) Fühler gegen die Spitze stark erweitert und abgeplattet; Käfer anders gefärbt; Punktstreifen sehr fein...... *Cistelodema* g. nov.

Genus CTEISODES novum

Die Gattung ist nahe mit *Borboresthes* Fairm. verwandt. Kopf kurz, Endglied der Kiefertaster nach aussen schwach, nach innen sehr stark erweitert, mindestens dreimal so lang, Endglied der Lippentaster breit, innere Spitze stärker erweitert als die äussere. Oberlippe kurz, sehr stark quer, nicht ausgerandet; Clypeus sehr kurz. Augen quer, stark gewölbt, vorstehend, ausgerandet, Abstand gross. Schläfen sehr kurz. Fühler fadenförmig, halb so lang wie der Körper. Halsschild stark quer, stark gewölbt, viel breiter als der Kopf mit den Augen, allseitig sehr deutlich gerandet, Seiten von der Mitte abgerundet verengt, Vorderecken deutlich, Apex bogenförmig ausgeschnitten, Basisecken rechtwinklig, Basis in der Mitte schwach und breit vorgezogen, ohne deutliche Grübchen. Schildchen spitz zungenförmig. Flügeldecken wenig breiter als die Halsschildbasis mit vertieften Punktstreifen und vorn ausgehölten Epipleuren. Beine mit gekeulten Schenkeln, 3. und 4. Glied der Vorder- und Mittelfüsse, 4. der Hinterfüsse lappig erweitert. Die Gattung unterscheidet sich von *Allecula* Fairm. durch ihre kurze Form, den allseitig sehr deutlich gerandeten Halsschild und seine nicht verrundeten Vorderecken. Die Type der Gattung ist *Ct. sericea*

m. Die Gattung ist von den Philippinen und Sumatra bekannt. Hierher gehört *Allecula cteisa* Borchm.[1]

CTEISODES SERICEA sp. nov.

Länge 5 mm. Länglich-oval, ziemlich gewölbt, mässig glänzend; fein, kurz, anliegend, ziemlich dicht, dunkel behaart, Flügeldecken durch äusserst feine Grundskulptur in schräger Ansicht bläulich seidenglänzend; dunkelbraun, Füsse, Fühler, Abdomen gegen die Spitze, Oberlippe und Vorderrand des Clypeus etwas heller, Oberseite fast schwarz. Kopf bis an die Augen in den Halsschild eingezogen, dicht und stark punktiert; Oberlippe stark quer, rotbraun beborstet; Clypeus stark quer, vorn gerade, von der Stirn durch eine feine, gebogene, glatte Linie abgesetzt; Stirn gewölbt; Halsfurche undeutlich; Fühler kräftig, 3. und 4. Glied gleich, Endglied so lang wie das 10.; Halsschild so lang wie die halbe Basis, ziemlich gewölbt, mit feiner, dichter Grundskulptur, ziemlich dicht und fein punktiert, Seiten vor der Mitte sehr leicht ausgeschweift, etwa von der Mitte abgerundet verengt, Apex so breit wie zwei drittel der Basis, alle Ränder von oben sichtbar. Flügeldecken in der Grundskulptur sehr fein und ziemlich dicht punktiert; Punktstreifen fein, vertieft, nicht sehr dicht punktiert, 4. und 5. Streifen endigen frei, Zwischenräume nur an den Seiten stärker gewölbt, oberer Seitenrand der Epipleuren von oben sichtbar, Epipleuren vorn breit und ausgehöhlt, erreichen die Spitze; Schultern kurz abgeschrägt verengt, daher die Basis nicht breiter als die Halsschildbasis, Spitzen zusammen abgerundet. Prosternalfortsatz ziemlich breit; Brust grob und ziemlich dicht punktiert, Hinterleib feiner, längsrissig, 4. und 5. Segment einfach fein und ziemlich dicht punktiert. Beine kräftig, Schenkel keulig, fein und sehr dicht, Schienen gerade und gröber punktiert, beide fein und anliegend behaart, Spitze der Hinterschenkel überragt den Hinterrand des 3. Segments nur wenig; Analsegment breit gerundet; Metatarsus der Hinterfüsse länger als die folgenden Glieder zusammen; Bildung der Füsse siehe Gattungsbeschreibung!

SIBUYAN, 1 Männchen, gesammelt von Prof. C. F. Baker, in meiner Sammlung.

Cteisodes cteisa m. von Sumatra ist äusserst ähnlich; aber ihr Halsschild ist in der Grundskulptur viel zerstreuter punktiert, an den Seiten stärker ausgeschweift, und die Oberseite länger und hell behaart.

[1] Ent. Mitt. 17 (1928) 411. Sumatra.

Genus CISTELOPSIS Fairmaire

Cistelopsis FAIRMAIRE, Ann. Soc. Ent. Belg. 40 (1896) 89.

Die Gattungsvertreter sind länglich-oval, mehr oder weniger gewölbt und alle schwarz bis braun gefärbt. Der Kopf ist kurz und bis an die Augen in den Halsschild eingezogen. Die Mandibeln sind zweispitzig; das Endglied der Kiefertaster ist breit, nach innen meist weniger als nach aussen erweitert, das Endglied der Lippentaster breit beilförmig. Die Oberlippe ist stark quer und höchstens äusserst leicht ausgerandet, der Clypeus quer, nach vorn verengt, von der Stirn mehr oder weniger deutlich abgesetzt. Die Augen sind quer, stark ausgerandet und zuweilen einander sehr genähert. Die meist kräftigen Fühler überragen selten die Körpermitte; die Glieder sind mehr oder weniger lang dreieckig, vom 4. Gliede an breiter, etwas flach und schwach gesägt, 3. und 4. Glied meist gleich, das 11. fast immer verkehrt eiförmig. Die Schläfen sind immer sehr kurz; die Halsfurche ist oft sehr undeutlich. Der Halsschild ist mehr oder weniger gewölbt, sehr oft mit feinster Grundskulptur, meistens fast halbkreisförmig und immer allseitig scharf gerandet, mit doppelt geschwungener Basis, die in der Mitte breit und schwach vorgezogen ist. Das halb sechseckige Schildchen ist dicht punktiert. Die gewölbten Flügeldecken sind am Grunde so breit wie die Halsschildbasis. Die Punktstreifen sind nie stark vertieft und meistens so gross wie die Punkte auf den Zwischenräumen. Diese sind reihig punktiert und behaart. Die Epipleuren sind vorn ziemlich breit, verengen sich allmählich und erreichen nicht die Spitze. Diese sind fast immer sehr kurz einzeln gerundet. Die Brust ist stark und dicht, das Abdomen sehr viel feiner, oft etwas längsrissig punktiert. Der Prosternalfortsatz ist nach hinten spitzenartig wagerecht zwischen die Mittelhüften verlängert. Die Beine sind ziemlich kurz und haben meist stark keulige Schenkel; die Hinterschenkelspitze überragt selten den Hinterrand des 3. Segments. Die Hinterschenkel sind am Hinterrande in der zweiten Hälfte (wenigstens bei den Männchen) scharf gerandet, die Schienen sind gerade. An den Vorder- und Mittelfüssen sind die beiden vorletzten, an den Hinterfüssen ist das vorletzte Glied unten lappig erweitert. Die Hintertarsen sind lang, der Metatarsus ist meistens so lang wie die folgenden Glieder zusammen. Die Gattung unterscheidet sich von *Allecula* durch die kurze Form, die Flügeldeckenskulptur und den allseitig scharf gerandeten Halsschild, von *Borboresthes*, die auf den Philippinen nicht vorzukommen scheint, durch die nach hinten langsamer verengten Flügeldecken, die

Flügeldeckenskulptur und den eigenartig verlängerten Prosternalfortsatz. Die Gattung ist über Süd- und Hinterasien und die Inselflur verbreitet.

Bestimmungstabelle der Arten.

1 (14) Die Punktstreifen der Flügeldecken sind in der vorderen Hälfte nicht vertief, die Zwischenräume hier völlig flach, die Punkte der Zwischenräume so stark wie die Punkte in den Streifen.

2 (11) Halsschild in der Mitte der Basis wenigstens ebenso stark punktiert wie die Streifen.

3 (10) Käfer nicht auffallend gestreckt.

4 (5) Käfer durchweg schwarz oder dunkel schwarzbraun, nur die Fühlerwurzel und die Beine heller. Länge 4 bis 6 mm. Halsschild mit Grundskulptur; Flügeldecken besonders in der zweiten Hälfte schwarz behaart; Fühler die Körpermitte lange nicht erreichend, 3. und 4. Glied gleich; Halsschild wenig gewölbt, grob und dicht punktiert. Mindanao und Samar .... *C. atrata* sp. nov.

5 (4) Käfer heller oder dunkler braun.

6 (7) Halsschild gleichmässig gewölbt. Länge 5.5 bis 6 mm. Behaarung hell; hell gelblichrotbraun, Kopf etwas dunkler, Fühler und Analsegment braun. Fühler ein drittel der Körperlänge, 3. Glied etwas länger als das 4.; Endglied der Kiefertaster gleichmässig erweitert. Halsschild grob und dicht punktiert; Flügeldecken mässig gewölbt, grob punktiert. Palawan.
C. grossepunctata sp. nov.

7 (6) Halsschild vorn deutlich stärker gewölbt.

8 (9) Augenabstand beim Männchen kaum mehr als ein halber Durchmesser. Länge 5 bis 5.5 mm. Dunkelbraun, Beine und Halsschild meistens etwas heller, Fühler mit Ausnahme der 3 Grundglieder schwarz. Augenabstand beim Männchen ein Viertel Durchmesser; Fühler die Schultern wenig überragend, 9. und 10. Glied ein Viertel länger als an der Spitze breit, 3. und 4. Glied gleich. Halsschild gröber punktiert als die Flügeldecken, Vorderrand nicht gleichmässig gerundet. Flügeldecken ziemlich gewölbt. Borneo .... *C. sandakana* sp. nov.

9 (8) Augenabstand bedeutend grösser. Länge 5 bis 5.5 mm. Dunkel rotbraun, Füsse und Fühlerwurzel wenig heller. Augenabstand fast ein Durchmesser; Fühler kräftig, vorletzte Glieder kaum länger als an der Spitze breit, 3. und 4. Glied gleich. Halsschild wenig gewölbt, fast so glänzend wie die Flügeldecken, dicht und stark punktiert. Punkte auf den Zwischenräumen vorn länglich. Mindanao, Luzon, Samar .... *C. planicollis* sp. nov.

10 (3) Form gestreckter. Länge 4.5 bis 5 mm. Heller oder dunkler braun bis schwärzlich, Hinterleibsspitze dunkler, Füsse, Fühlerwurzel und meist die Flügeldecken rotbraun. Augenabstand etwa zwei Drittel Durchmesser; 3. Fühlerglied wenig kürzer als das 4.; Halsschild halbkreisförmig, grob punktiert. Luzon.
C. luzonica sp. nov.

11 (2) Halsschild in der Mitte viel feiner punktiert als die Flügeldecken.

12 (13) Halsschild wenig gewölbt. Länge 5 bis 6 mm. Heller oder dunkler rotbraun, zwei letzte Hinterleibsringe oft dunkler, Beine und 3 Fühlerwurzelglieder bedeutend heller, die übrigen Glieder schwarz. Augenabstand ein halber Durchmesser; Fühler schlanker, fast die Körpermitte erreichend, 3. Glied kürzer als das 4.; Halsschild halbkreisförmig, ziemlich grob punktiert. Mindanao, Luzon, Negros, Nord-Palawan.................. *C. ferrugata* sp. nov.

Vielleicht ist diese Art synonym mit *C. ferruginea* Pic, Mél. exot.-ent. 55 (1930) 24. Da ich sie nach der Beschreibung nicht in die Tabelle einreihen kann, stelle ich ihre Beschreibung hierher: "*C. ferruginea* n. sp. Oblongo-elongatus, rufo-testaceus, pedibus elytrisque pallidioribus, antennis nigris, ad basim testaceis; thorace robusto, sat minute, diverse, pro parte sparse, punctato; elytris minute striatis, intervallis bilineato punctatis. Long. 5 mm. Palawan."

13 (12) Halsschild wenigstens vorn stark gewölbt. Länge 5 bis 6 mm. Heller oder dunkler rotbraun bis pechbraun, Unterseite an den Rändern oft heller, Fühler mit Ausnahme der drei bis vier Grundglieder schwarz, Beine zuweilen mit hellen Tarsen. Kopf ziemlich fein punktiert; Endglied der Kiefertaster gleichmässig erweitert, 3. Glied etwas kürzer als das 4.; Halsschild im vorderen Drittel etwas stärker gewölbt und feiner punktiert. Basilan .... *C. basilana* sp. nov.

Drittes Fühlerglied länger; Käfer dunkelbraun, Halsschild und Seiten und Spitze der Flügeldecken dunkler. Borneo. *brunnea* var. nov.

14 (1) Punktstreifen auch in der vorderen Hälfte deutlich vertieft, Punkte auf den Zwischenräumen oft sehr fein.

15 (18) Die Fühler erreichen oder überragen die Körpermitte bedeutend.

16 (17) Die Hinterschenkel sind nicht besonders stark keulig und nach hinten nicht auffällig erweitert. Länge 5 bis 5.5 mm. Ziemlich gestreckt, wenig gewölbt dunkelbraun, Beine und die Fühler zuweilen gegen die Spitze heller. Endglied der Kiefertaster sehr breit, äussere Spitze stärker erweitert; Augen grosz, quer; Fühler schlank, die Körpermitte weit überragend, fast fadenförmig, 3. und 4. Glied gleich. Halsschild halbkreisförmig, Basisecken nach hinten deutlich vorgezogen. Flügeldecken mindestens viermal so lang wie der Halsschild. Benguet und Nueva Vizcaya .... *C. castanea* sp. nov.

17 (16) Hinterschenkel stark keulig, in scharfer Kante nach hinten erweitert. Länge 5.5 mm. Weniger schlank; dunkelbraun, Hinterleib, Fühler, Füsse und Oberseite heller, Flügeldecken am Rande bei den Schultern schmal, nach der Mitte zu breit schwarz, der schwarze Fleck erreicht nicht die Naht und hört eben hinter der Mitte mit unbestimmter Grenze auf. Fühler erreichen die Körpermitte. Augenabstand kaum ein funfter Durchmesser. Flügeldecken hinter dem Schildchen etwas buckelig gewölbt. Mindanao .... *C. similis* sp. nov.

18 (15) Fühler dicker und kürzer.

19 (20) Käfer grösser; Punkte auf den Zwischenräumen vorn nicht viel feiner als die Punkte der Streifen. Länge 6 mm. Dunkelbraun,

Fühler, und Beine rotbraun; Augen klein, Abstand ein und ein halber Durchmesser; Endglied der Kiefertaster nach aussen viel stärker erweitert. Punkte in den Streifen wenig stärker als die Punkte auf den Zwischenräumen. Mindanao.
C. dapitana sp. nov.

20 (19) Käfer sehr klein; Punkte der Zwischenräume sehr viel feiner als die Punkte in den Streifen.

21 (22) Endglied der Fühler hell. Länge 3 bis 3.5 mm. Länglich-oval; rotbraun, Fühler mit Ausnahme der drei bis vier Wurzelglieder und des 11. (zuweilen auch des 10.) schwarz. Augen rundlich; 3. Fühlerglied etwas kürzer als das 4.; Punkte in den Streifen ziemlich grob, dicht, viel stärker als die Punkte der Zwischenräume. Mindanao, Basilan, Tangkulan, Borneo.
C. pici sp. nov.

22 (21) Fühler meistens hell, wenn dunkel, ohne helles Endglied. Länge 2.5 bis 3.5 mm. Körper etwas kürzer, Halsschild gröber und dichter punktiert, Punktstreifen gröber und stärker vertieft. Basilan .... *nana* var. nov.

Unbekannt blieb mir *C. palawana* Pic, Mél. exot.-ent. 55 (1930) 24, deren Beschreibung hier folgt. "Oblongo-clongatus, castaneus, pedibus rufescentibus; thorace sat robusto, minute et sparse punctato; elytris supra minute non regulariter striatis, intervallis deplanatis, multi punctatis. Long. 5 mm. Palawan."

NEUBESCHREIBUNGEN

CISTELOPSIS BASILANA sp nov.

Länge 5 bis 6 mm. Länglich-oval, mässig gewölbt, mässig glänzend; anliegend, reihig, mässig lang, gelblich behaart; heller oder dunkler rotbraun bis pechbraun, Unterseite an den Rändern oft heller, Fühler mit Ausnahme der drei bis vier Grundglieder schwarz, Beine zuweilen dunkel mit hellen Tarsen. Kopf ziemlich fein, wenig dicht punktiert; Oberlippe sehr kurz, sehr schwach ausgerandet; Clypeus sehr stark quer, nach vorn verengt, Trennungsfurche tief; Schläfen sehr kurz; Endglied der Kiefertaster gleichmässig erweitert; Augenabstand ein halber Durchmesser; die kräftigen Fühler erreichen lange nicht die Körpermitte, Glieder schwach dreieckig, 3. Glied etwas kürzer als Glied 1. und 2. zusammen, wenig kürzer als das 4., dieses etwas dicker Endglied eiförmig. Halsschild so lang wie die halbe Basis, mit feinster Grundskulptur, im vorderen Drittel etwas stärker gewölbt und feiner punktiert, Punkte an den Seiten etwas gröber als die Punkte der Flügeldecken, allseitig scharf gerandet, mit den gewöhnlichen Eindrücken. Schildchen quer, halb sechseckig. Flügeldecken vom Ende des ersten Drittels an langsam gerundet verengt, Punkte mittelstark, Streifen nur

an den Seiten und nahe der Spitze schwach vertieft. Unterseite vorn stark, Abdomen fein punktiert, an einigen Stellen etwas längsrissig; Beine ziemlich dicht und stark punktiert; Hintertarsen zwei Drittel bis drei Viertel so lang wie die Schiene; Metatarsus der Hinterfüsse kaum so lang wie die folgenden Glieder zusammen; Analsegment am Ende gerundet.

BASILAN, 20 Exemplare in meiner Sammlung, 1 von Prof. Baker gesammelt, die andern von G. Böttcher. Davon erhielt ich aus der Sammlung Korschefsky 8; im Deutschen Ent. Institut befinden sich aus derselben Sammlung noch 3 Tiere.

Die Art steht der *C. denselineata* Bm. nahe, ist aber durchweg heller, kleiner, und kürzer behaart. Ihr Halsschild ist stärker gewölbt und etwas länger; ihre Füsse sind länger.

Die Varietät *brunnea* m. von Borneo, Sandakan (*C. F. Baker*), hat ein längeres 3. Fühlerglied und ist dunkelbraun, mit dunklerem Halsschild und dunkleren Seiten und Flügeldeckenspitzen.

CISTELOPSIS ATRATA sp. nov.

Länge 4 bis 6 mm. Form gewöhnlich; ziemlich glänzend, Halsschild mit Grundskulptur und daher matter; Flügeldecken schwarz (besonders in der zweiten Hälfte) behaart; pechbraun, Beine etwas heller oder rotbraun, Mundteile braun, Unterseite stellenweise heller, drei Grundglieder der Fühler braun, Oberseite mehr oder weniger schwarz oder pechschwarz; 1 Exemplar hat pechbraune Flügeldecken. Kopf normal; Endglied der Kiefertaster nach aussen stärker erweitert; Augenabstand etwa zwei Drittel bis ein halber Durchmesser; Fühler kräftig, die Körpermitte lange nicht erreichend, 3. und 4. Glied gleich. Halsschild wenig gewölbt, kaum halb so lang wie die Basis, grob und ziemlich dicht, in der Mitte kaum schwächer punktiert, Apex weniger gerundet; Flügeldecken bis zum Anfang des letzten Drittels sehr schwach erweitert, dann gerundet verengt, Punkte in den Streifen so stark wie die Halsschildpunkte, Streifen nur an den Seiten und nahe der Spitze vertieft. Unterseite glänzend; Abdomen ziemlich grob, etwas längsrissig punktiert, Analsegment abgestutzt; Beine normal, Hintertarsen ein Halb bis zwei Drittel der Schiene; Metatarsus fast so lang wie die folgenden Glieder zusammen.

MINDANAO, Dapitan, Davao (*10122, 15837*), Iligan (*4623, 6822, 15832,* und *23584*), 17 Exemplare, alle gesammelt von Prof. Baker, in meiner Sammlung. Von Kolambugan (*Böttcher*) und Samar (*Baker*). Von Mindanao, Davao, befinden sich ausserdem noch 5 Tiere, die von Prof. Baker gesammelt

sind, unter den Nr. 6829, 6830 in meiner Sammlung. Drei Exemplare von Luzon, Mount Maquiling, Dapitan (*Baker 4623*) und Kolambugan, 1924, im Museum Dresden.

Die Art fällt auf durch die starke Punktierung des Halsschildes und die dunkle Färbung. Von *C. denselineata* m. unterscheidet sie sich durch den gröber punktierten, flacheren Halsschild.

CISTELOPSIS GROSSEPUNCTATA sp. nov.

Länge 5.5 bis 6 mm. Mässig gewölbt, mässig glänzend, Behaarung normal; hell gelblichrotbraun, Kopf etwas dunkler, Fühler und Analsegment braun. Kopf grob und dicht punktiert, Oberlippe und Clypeus normal; Augenabstand ein halber bis drei Viertel Durchmesser; Fühler kräftig, ein Drittel Körperlänge, Glieder dreieckig, 3. Glied etwas länger als das 4., Endglied eiförmig; Endglied der Kiefertaster gleichmässig erweitert. Halsschild mässig gewölbt, grob und dicht punktiert, kaum halb so lang wie die Basis, Apex wenig flacher gerundet als die Seiten. Flügeldecken mässig gewölbt, grösste Breite eben vor der Mitte, grob punktiert, Skulptur normal. Unterseite ziemlich stark glänzend; Beine normal; Hintertarsen ein Halb bis zwei Drittel der Schiene, Metatarsus so lang wie die folgenden Glieder zusammen. Analsegment abgerundet.

PALAWAN, Puerto Princesa (*Baker 5985, 23585*), 4 Exemplare in meiner Sammlung. Ein Exemplar vom selben Fundort im Museum Dresden.

Die Art ist mit *C. atrata* m. verwandt, unterscheidet sich aber durch die schwächere Wölbung der Flügeldecken, ihre gröbere Punktierung, das längere 3. Fühlerglied und die kürzeren Hintertarsen.

CISTELOPSIS SANDAKANA sp. nov.

Länge 5 bis 5.5 mm. Form gewöhnlich; mässig gewölbt, mässig glänzend; Behaarung normal; dunkelbraun, Beine und Halsschild meistens etwas heller, Fühler mit Ausnahme der drei Grundglieder schwarz. Kopf ziemlich grob und undicht punktiert; Augenabstand fast ein Durchmesser, beim Männchen ein Viertel; Fühler die Schultern wenig überragend, beim Männchen langer, schwach gesägt, etwas platt, 9. und 10. Glied ein Viertel länger als an der Spitze breit, 3. und 4. gleich. Halsschild kaum halb so lang wie die Basis, in der Basishälfte wenig gewölbt, quer eingedrückt, gröber punktiert als die Flügeldecken, Eindrücke vehältnismässig tief, Vorderrand nicht gleichmässig ge-

rundet. Flügeldecken ziemlich gewölbt, grösste Breite in der Mitte, Streifung und Punktierung gewöhnlich. Unterseite glänzender, Abdomen stark und weitläufig punktiert, Analsegment abgestutzt; Beine normal, Hintertarsen drei Viertel der Schiene, Metatarsus so lang wie die folgenden Glieder zusammen; beim Weibchen sind die Tarsen etwas kürzer.

BORNEO, Sandakan (*Baker, 10122, 15837*), 9 Exemplare in meiner Sammlung. Die Art hat Ähnlichkeit mit *grossepunctata* m., ist aber dunkler, hat viel gröber punktierten und an der Basis niedergedrückten Halsschild.

CISTELOPSIS LUZONICA sp. nov.

Länge 4.5 bis 5 mm. Form etwas gestreckter, mässig gewölbt, mässig glänzend; Behaarung gewöhnlich; heller oder dunkler braun bis schwärzlich, Spitze des Hinterleibes dunkler, Füsse, Fühlerwurzel und meist die Flügeldecken rotbraun. Kopf dicht und grob punktiert; Augenabstand etwa zwei Drittel Durchmesser; 3. Fühlerglied wenig kürzer als das 4., Endglied eiförmig; äussere Spitze des Kiefertasterendgliedes etwas stärker erweitert. Halsschild gewölbt, halb so lang wie die Basis, halbkreisförmig, Punktierung grob, in der Mitte etwas schwächer, aber noch so stark wie die Punkte auf den Flügeldecken. Flügeldecken glänzender, grösste Breite weit vor der Mitte, dann langsam und gleichmässig gerundet verengt, Punkte auf den Zwischenräumen mittelstark, Punktstreifen nur an den Seiten und an der Spitze schwach vertieft. Unterseite und Beine normal; Hinterfüsse zwei Drittel der Schiene, Metatarsus länger als die folgenden Glieder zusammen.

LUZON, Cabugao (*G. Böttcher*) und Montalban (*Böttcher*), 7 Exemplare in meiner Sammlung. Ein Tier von Montalban ist bedeutend heller, etwas glänzender und gewölbter, stimmt aber sonst gut mit den übrigen überein. Vier Exemplare von Luzon, Mount Banahao, 1924, im Museum Dresden. Die Tiere sind schwächer.

Die Art ist der *C. grossepunctata* m. nahe, ist aber dunkler, gestreckter, hat feiner punktierte Flügeldecken. Von *atrata* m. weicht sie durch schlankere Form und gleichmässige Rundung des Halsschildes ab.

CISTELOPSIS FERRUGATA sp. nov.

Länge 5 bis 6 mm. Mässig gewölbt, ziemlich glänzend; Behaarung normal; heller oder dunkler rotbraun, zwei letzte Hinterleibsringe oft dunkler, Beine und drei Fühlerwurzelglieder be-

deutend heller, übrige Fühlerglieder schwarz. Kopf kurz, fein und un dicht punktiert; Oberlippe und Clypeus stark quer; Augenabstand ein halber Durchmesser; Fühler fast die Körpermitte erreichend, schlanker als gewöhnlich, Glieder viel länger dreieckig, 3. Glied kürzer als das 4.; innere Ecke des Kiefertasterendgliedes wenig kürzer als die äussere. Halsschild sehr mässig gewölbt, halbkreisförmig, ziemlich grob punktiert, so stark wie die Flügeldecken, in der Mitte der Basis flachgedrückt. Grösste Breite der Flügeldecken etwa in der Mitte, Punkte länglich, gegen die Spitze feiner. Unterseite glänzender, Abdomen stellenweise fein längsrissig; Hintertarsen zwei Drittel der Schiene; Metatarsus der Hinterfüsse länger als die folgenden Glieder zusammen.

LUZON, Mount Maquiling, Los Baños; MINDANAO, Butuan, Dapitan, Surigao; NEGROS, Cuernos Mountains, 16 Tiere in meiner Sammlung, alle gesammelt von Prof. C. F. Baker, unter den Nr. 4655, 15835, 15843 und 23587. Im Museum in Dresden befindet sich eine grosse Zahl von Tieren von Luzon, Mount Maquiling (*Baker, 4655*); Mindanao, Butuan (*Baker, 4645, 4647*), und Iligan, 1924; Palawan, Puerto Princesa (*Baker*).

N. PALAWAN, Bacuit, Dezember, 1913 (*Böttcher*), 5 Exemplare sind höchst ähnlich und unterscheiden sich nur durch etwas gewölbteren und vorn ein wenig feiner punktierten Halsschild.

Die Art ist *C. luzonica* m. sehr ähnlich, ist aber breiter und hat viel gestrecktere Fühlerglieder und feiner punktierte Flügeldecken.

CISTELOPSIS PLANICOLLIS sp. nov.

Länge 5 bis 5.5 mm. Sehr ähnlich der *C. grossepunctata* m., ist aber kleiner; ihr Halsschild ist weniger gewölbt; mässig gewölbt, mässig glänzend, mit der gewöhnlichen Behaarung; dunkel rotbraun, Füsse und Fühlerwurzel wenig heller. Kopf ziemlich grob, Stirn undicht punktiert; Augenabstand fast ein Durchmesser; Fühler kräftig, vorletzte Glieder kaum länger als an der Spitze breit, etwas flach, 3. Glied so lang wie das 4. Halsschild wenig gewölbt, fast so glänzend wie die Flügeldecken, so lang wie die halbe Basis, Halbkreisform etwas gestört, dicht und stark punktiert, vorn kaum schwächer, Eindrücke normal. Flügeldecken gleich hinter den Schultern am breitesten; Punkte in den Streifen kräftig, Punkte auf den Zwischenräumen ebenso stark, Punkte länglich. Abdomen spärlich punktiert; Hintertarsen zwei Drittel der Schiene, Metatarsus länger als die folgenden Glieder zusammen.

MINDANAO, Davao (*Baker*); LUZON, Benguet, La Trinidad, Mai 1913 (*G. Böttcher*); SAMAR (*Baker*); 8 Exemplare. Im Museum in Dresden befinden sich 2 Exemplare von Mindanao, Butuan (*Baker*) und Luzon, Trinidad, 1924.

Die Art steht der *C. grossepunctata* m. nahe; aber ihr Halsschild und ihre Flügeldecken sind viel weniger grob punktiert. Die Punkte sind länglich, die Hintertarsen sind länger, u. s. w.

CISTELOPSIS PICI sp. nov.

Länge 3 bis 3.5 mm. Länglich-oval, mässig gewölbt, ziemlich glänzend, ziemlich lang, fast anliegend, gelblichbraun behaart; rotbraun, Fühler mit Ausnahme der drei bis vier Wurzelglieder und des Endgliedes (zuweilen zwei) schwarz. Kopf ziemlich fein und dicht punktiert, Clypeus wenig gewölbt; Augen rundlich, Abstand etwa ein Durchmesser; Halsfurche nicht erkennbar; Endglied der Kiefertaster nach aussen wenig mehr als nach innen erweitert; Fühler kräftig, die Körpermitte nicht ganz erreichend, Glieder gestreckt, 3. Glied etwas kürzer als das 4., 11. so lang wie das 10., stumpf schräge zugespitzt. Halsschild gewölbt, ziemlich fein und sehr dicht punktiert, nicht ganz halb so lang wie die Basis, Apex etwas weniger gerundet, Eindrücke deutlich. Schildchen zungenförmig. Flügeldecken ziemlich gewölbt, grösste Breite vor der Mitte, ganz allmählich verengt; Punktstreifen ziemlich grob, Punkte dicht, viel stärker als die Punkte auf den Zwischenräumen, Punkstreifen vorn leicht vertieft, an den Seiten und in der Spitze stärker, Zwischenräume vorn fast flach, sehr fein, fast zweireihig punktiert; Epipleuren und Spitze gewöhnlich. Unterseite glänzender, Hinterleib sehr fein und zerstreut punktiert; Analsegment beim Männchen leicht ausgerandet; Hintertarsen drei Viertel der Schiene, Metatarsus länger als die folgenden Glieder zusammen.

BASILAN; MINDANAO, Kolambugan, und Bukidnon, Tangkulan, 3 Exemplare von Prof. Baker gesammelt, in meiner Sammlung, Nr. 15834, 15839, und 15841. Ausserdem besitze ich 2 Exemplare von Borneo, Sandakan, von Prof. Baker gesammelt. Das Museum in Dresden besitzt 2 Exemplare von Mindanao, Kolambugan, 1924, und 1 Stück der Parietät von Dapitan (*Baker*).

Das Tier ähnelt stark gewissen *Borboresthes*-Arten. Von allen *Cistelopsis*-Arten unterscheidet die Art sich durch ihre geringe Grösse, ihre verhältnismässig stark eingedrückten Punktstreifen und die undeutlich gelappten Tarsen.

Varietät *nana* m., 2.5 bis 3.5 mm. Fühler meist ganz hell, aber wenn dunkel, ohne helles Endglied; Körper etwas kürzer,

Halsschild gröber und dichter punktiert, Flügeldecken mit gröberen, stärker vertieften Streifen.

BASILAN (*Baker, 15840*), 4 Exemplare in meiner Sammlung.

CISTELOPSIS CASTANEA sp. nov.

Länge 5 bis 5.5 mm. Ziemlich gestreckt, wenig gewölbt, mässig glänzend, normal behaart; dunkelbraun, Beine und die Fühler zuweilen gegen die Spitze heller. Kopf ziemlich dicht und stark punktiert; Oberlippe stark quer, gewölbt, glänzend, vorn kaum ausgerandet; Clypeus normal; Stirn gewölbt; Halsfurche deutlich; Endglied der Kiefertaster sehr breit, äussere Spitze stärker erweitert; Augen gross, quer, Abstand kaum ¼ Durchmesser; Fühler schlank, fast fadenförmig, Glieder lang, schmal dreieckig, 3. und 4. Glied gleich, folgende Glieder kaum kürzer, Endglied lang zugespitzt, so lang wie das 10. Halsschild wenig gewölbt, halbkreisförmig, sehr dicht mittelstark punktiert, Basisecken schwach nach hinten vorgezogen, nicht abgerundet, Eindrücke kaum erkennbar. Flügeldecken wenigstens viermal so lang wie der Halsschild, mässig gewölbt, Punktstreifen so stark wie die Halsschildpunkte, deutlich vertieft, Zwischenräume wenig gewölbt, reihig punktiert, Seiten bis zur Mitte äusserst schwach erweitert; Epipleuren dicht und fein punktiert; Brust grob und ziemlich dicht, Abdomen sehr fein und dicht punktiert; Analsegment abgestutzt und vor der Spitze breit quer eingedrückt; Beine mit stark keuligen, etwas platten Schenkeln; Hintertarsen zwei Drittel der Schienen, Metatarsus länger als die folgenden Glieder zusammen.

LUZON, Benguet, Baguio, und Nueva Vizcaya, Imugan (*Baker, 6821* und *15833*), 2 Männchen in meiner Sammlung.

Die Art entfernt sich durch den flachen Halsschild und die langen Fühler auffällig von allen andern.

CISTELOPSIS SIMILIS sp. nov.

Länge 5.5 mm. Etwas weniger schlank als *C. castanea* m., nach hinten stärker verengt; dunkelbraun, Hinterleib, Füsse, Fühler und Oberseite heller, Flügeldecken am Rande bei den Schultern schmal, nach der Mitte zu breit schwarz, der schwarze Fleck erreicht nicht die Naht und hört eben hinter der Mitte mit unbestimmter Grenze auf. Fühler erreichen die Körpermitte, etwas kräftiger als bei *castanea*, 3. und 4. Glied gleich, Endglied schräg zugespitzt. Augen stark genähert, Abstand kaum ein Fünftel Durchmesser. Halsschild wie bei *castanea*, stark und dicht punktiert, Basiswinkel sehr deutlich nach hinten

vorgezogen. Flügeldecken hinter dem Schildchen etwas buckelig gewölbt, Beine stark keulig, zweite Hälfte der Hinterschenkel hinten scharf gerandet. Hintertarsen drei Viertel der Schiene, Metatarsus bedeutend länger als die folgenden Glieder zusammen; Analsegment wie bei *C. castanea* m.

MINDANAO, Iligan (*Baker, 15831*), 1 Männchen in meiner Sammlung.

Cistelopsis dapitana m. ist breiter und die Basisecken ihres Halsschildes sind kaum erkennbar vorgezogen. Ihre Hintertarsen sind viel kürzer.

CISTELOPSIS DAPITANA sp. nov.

Länge 6 mm. Mässig gewölbt, mässig glänzend, normal behaart; dunkelbraun, Fühler und Beine rotbraun. Kopf dicht und mässig stark punktiert; Stirn schwach gewölbt; Halsfurche nicht erkennbar; Augen ziemlich klein, Abstand ein und ein halber Durchmesser; Fühler die Körpermitte nicht erreichend, ziemlich schlank, Glieder lang schwach dreieckig, 3. und 4. Glied gleich, Endglied zugespitzt; Endglied der Kiefertaster nach aussen viel stärker erweitert als nach innen. Halsschild mässig, vorn stärker gewölbt, fast halbkreisförmig, sehr dicht punktiert, mit deutlicher Grundskulptur, Eindrücke deutlich, Basisecken sehr schwach nach hinten vorgezogen. Flügeldecken mässig gewölbt, bis zur Mitte schwach erweitert; Punktstreifen schwach vertieft, wenig stärker punktiert als die Zwischenräume, deren Punkte wenig feiner sind als die Halsschildpunkte. Epipleuren dicht und fein punktiert. Unterseite glänzender, Hinterleib fein und undicht punktiert, fein und zerstreut längsrissig; Analsegment kurz abgestutzt, vor der Spitze mit breitem und flachem Quereindruck; Beine mit keuligen Schenkeln; Hintertarsen zwei Drittel der Schiene, Metatarsus so lang wie die folgenden Glieder zusammen.

MINDANAO, Dapitan (*Baker*), 1 Männchen in meiner Sammlung.

Die Art ist mit *C. castanea* m. verwandt, hat aber viel kürzere Fühler, gewölbteren Halsschild und breitere Flügeldecken. Von der ebenfalls ähnlichen *C. ferrugata* m. ist sie durch die eingedrückten Punktstreifen, die schlankeren Fühler und den stärker punktierten Halsschild gut geschieden.

Genus STILBOCISTELA novum

Die Vertreter dieser Gattung sind oval, stark glänzend und ziemlich gewölbt. Der Kopf ist kurz und bis an die Augen in

den Halsschild eingezogen. Das Endglied der Kiefertaster ist ziemlich breit dreieckig. Die Augen sind stark gewölbt, nicht sehr genähert, ausgerandet. Die Fühler erreichen etwa die Körpermitte, sind kräftig und vom 4. Gliede an sehr leicht flach; die einzelnen Glieder sind von hier ab schwach dreieckig. Der Halsschild ist stark quer, allseitig gerandet, vorn flach breit ausgerandet, mit abgerundeten Vorderecken, und scharfen Seitenrändern. Die Basis ist doppelt geschwungen und in der Mitte flach vorgezogen. Das Schildchen ist breit dreieckig. Die Flügeldecken sind am Grunde etwas breiter als die Halsschildbasis, haben starke Punktstreifen und fein und sehr undicht punktierte Zwischenräume. Der 1. und 2. Punktstreifen sind in der Spitze stark vertieft. Die Epipleuren sind breit, die Spitzen zusammen abgerundet und die Schultern etwas buckelig. Die Beine und Füsse sind wie bei *Cistelopsis*. Von dieser Gattung unterscheidet sich *Stilbocistela* durch die Form des Halsschildes und die Flügeldeckenskulptur.

Die Type der Gattung ist *St. luzonica* m. Nach anderen mir bekannt gewordenen, noch unbeschriebenen Arten verbreitet sich die Gattung bis Neu-Guinea.

STILBOCISTELA LUZONICA sp. nov.

Länge 5 bis 6 mm. Fast oval, ziemlich stark gewölbt, glänzend; Oberseite kahl, Unterseite und Beine ziemlich dicht, kurz behaart; dunkel rotbraun, die ersten zwei oder drei Fühlerglieder, die Ränder des Halsschildes, das Schildchen, Schulterbeule, die Naht, Spitze, hintere Hälfte des Seitenrandes der Flügeldecken, die Kniee, selten die ganzen Flügeldecken heller. Kopf so lang wie breit, bis an die Augen eingezogen, Oberlippe und Clypeus ziemlich dicht und kräftig, der übrige Kopf fein und zerstreut punktiert; Oberlippe quer, nicht erkennbar ausgerandet, Vorderecken kurz gerundet; Clypeus quer, vorn gerade, gegen die Spitze verengt, leicht gewölbt, von der Stirn deutlich bogenförmig abgesetzt; Stirn gewölbt; Augen kräftig ausgerandet, stark gewölbt, Abstand ein halber bis zu einem Durchmesser (Männchen und Weibchen); Schläfen fast geschwunden; Fühler halb so lang wie der Körper (Weibchen) oder etwas länger (Männchen), vom 3. Gliede an leicht gesägt, wenig flach, 1. und 3. Glied gleich, 2. halb so lang, 4. wenig länger als das 3., Endglied innen vor der Spitze schwach ausgerandet. Halsschild viel breiter als der Kopf, wenig schmäler als die Flügeldecken, mindestens doppelt so breit wie lang, gewölbt, stark glänzend, sehr fein und zerstreut punktiert, allseitig gerandet, Randung

in der Mitte des Vorderrandes unterbrochen, Basis in der Mitte breit und kräftig vorgezogen, Seiten nach vorn mässig gerundet verengt, Vorderrand breit und flach ausgeschnitten, Basisecken rechtwinklig, sehr kurz abgerundet, Vorderecken ziemlich breit verrundet. Schildchen glatt, kurz, breit dreieckig. Flügeldecken gewölbt, in der Mitte am breitesten; Punktstreifen kräftig, wenig vertieft, 1. und 2. Streifen hinten stärker eingedrückt; Zwischenräume fast flach, breit, vorn sehr fein, fast einreihig punktiert, 1. in der Spitze schmäler und stärker gewölbt, etwa ein Drittel so breit wie der 2.; Schulterbeule glatt; Seitenrand der Decken von oben sichtbar; Spitzen zusammen abgerundet; Epipleuren ziemlich breit, fast glatt, allmählich verengt; Unterseite sehr fein punktiert, Segmente am Vorder- und Hinterrand leicht längsrissig, Prosternalfortsatz oben breit, nach hinten etwas verlängert; Beine kräftig, dicht und fein punktiert und behaart, Schienen fast gerade; Metatarsus der Hinterfüsse so lang wie die folgenden Glieder zusammen.

LUZON, Baguio, 10 Exemplare (*Böttcher*) und 1 (*Baker*), in meiner Sammlung.

Zuweilen haben die Flügeldecken eine scharfe Zeichnung. Kopf und Halsschild sind dann schwarz, Schulterbeule, hintere Hälfte des Seitenrandes, die Spitze und die letzten zwei Drittel der Naht sind breit und ziemlich grell rot, die Beine, besonders die Tarsen, und die Fühler hell.

Drei Exemplare von Luzon, Baguio und Santo Tomas, gesammelt von F. Böttcher, in meiner Sammlung. Ich benenne diese auffallende Varietät *distincta* var. nov.

Genus ALLECULA Fabricius

Allecula FABRICIUS, Syst. Eleutheratorum 2 (1801) 21.

Die Vertreter dieser Gattung sind mehr oder weniger gestreckt, haben ein breit dreieckiges Kiefertasterendglied, das oft ungleichmässig nach innen und aussen erweitert ist. Das Endglied der Lippentaster ist mehr oder weniger beilförmig. Die Mandibeln sind zweispitzig; die Oberlippe ist mehr oder weniger querherzförmig. Die Augen sind fast immer stark gewölbt, sehr deutlich ausgerandet und oft stark genähert. Die Fühler sind meist fadenförmig, nie stark gesägt, das 2. Glied immer kurz, das 3. selten länger als das 4. Der Halsschild ist stumpfkantig, an der Basis und den Seiten und meist auch am Apex fein gerandet. Die Basis ist zweimal geschwungen. Die Flü-

geldecken haben kräftige Schultern und meist starke Punktstreifen. Der Prosternalfortsatz ist so hoch wie die Hüften und nicht schneidend. Das Abdomen hat fünf Segmente. Die Beine der Männchen zeigen oft Geschlechtsmerkmale. An den Vorder- und Mittelfüssen sind meist das 2. bis 4. Glied, an den Hinterfüssen ist nur das vorletzte Glied unten lappig erweitert. Die Vertreter dieser Gattung in unserem Gebiete gehören fast alle der Untergattung *Dietopsis* Sol. an, die sich durch kurzes, dreieckiges 1. Glied der Vordertarsen auszeichnet. Bisher waren von den Philippinen nur zwei Arten bekannt:

Allecula sericans FAIRMAIR, Ann. Soc. Ent Fr. VI 6 (1896) 190; BORCHMANN, Philip. Journ. Sci. 8 (1913) 57.
Allecula minuta PIC, Mél. exot.-ent. 12 (1915) 14.
Syn. *contempta* BORCHMANN, Ent. Mitt. 17 (1928) 408.

Bestimmungstabelle der Gattung Allecula Fabricius.

1 (10) Flügeldecken matt durch feine Grundskulptur, mindestens die Flügeldecken mit bläulichem Seidenglanz.

2 (3) Auch der Halsschild seidenglänzend, äusserst fein punktiert, nach Apex und Basis zu gleichmässig gerundet verengt. Länge 12 bis 14 mm. Kastanienbraun bis schwarz. Die Fühler halb so lang wie der Körper, 3. und 4. Glied gleich. Halsschild etwas quer; Zwischenräume der Punktstreifen ziemlich stark gewölbt, unpunktiert. Manila, u. s. w. .... *A. sericans* Fairm.

3 (2) Halsschild ohne erkennbaren Seidenglanz.

4 (7) Halsschild sehr deutlich quer.

5 (6) Halsschild sehr fein und dicht punktiert. Länge 11 mm. Pechbraun, Vorderkopf und Fühler heller, Flügeldecken dunkel rotbraun. Fühler dünn, die Körpermitte überragend, 4. Glied deutlich länger als das 3.; Augen nicht quer, Abstand fast ein Durchmesser. Halsschild drei Viertel so lang wie breit. Süd-Celebes .... *A. tenuepunctata* sp. nov.

6 (5) Halsschild dicht und grob punktiert. Länge 10.5 mm. Pechschwarz, Vorderkopf, Mundteile, Füsse und Fühler mehr dunkel rotbraun. Fühler dünn, fast zwei Drittel der Körperlänge, 3. und 4. Glied gleich; Augenabstand ein Durchmesser. Halsschild zwei Drittel so lang wie breit, grösste Breite vor der Mitte. Borneo, Sandakan .... *A. sandakana* sp. nov.

7 (4) Halsschild nicht deutlich quer.

8 (9) Apex der Flügeldecken mit kürzer Spitze, 3. Glied der Mitteltarsen breit. Länge 11.5 bis 14 mm. Oberseite halb abstehend, mittellang behaart, pechschwarz, Füsse, Endglied der Kiefertaster und die Fühler in der zweiten Hälfte heller. Fühler zwei Drittel der Körperlänge, 3. Glied deutlich kürzer als das 4.; Augenabstand etwas mehr als halber Durchmesser. Halsschild so lang wie breit, grösste Breite an der Basis. Jeder Zwischen-

raum der Punktstreifen mit zwei unordentlichen Punktreihen. Vielleicht das Weilechen der folgenden Art. Basilan.
A. pachyscelis sp. nov.

9 (8) Apex der Flügeldecken ohne Spitze, 3. Glied sehr wenig verbreitert. Länge 11 bis 12 mm. Undicht, ziemlich lang halb abstehend hellbraun behaart; pechschwarz, Flügeldecken oft dunkelbraün Schenkel dunkelbraun, Schienen, Fühler, Vorderkopf und Mundteile rotbraun. Augenabstand halb Durchmesser; Fühler länger als der halbe Körper, 4. Glied so lang wie das 2. und 3. zusammen. Halsschild etwas länger als breit. Zwischenräume der Punktstreifen mit weitläufigen, unordentlichen Borstenpunktreihen. Mindanao .... *A. dentipes* sp. nov.

10 (1) Flügeldecken nicht matt, nicht seidenglänzend.

11 (12) Punkte auf den Zwischenräumen der Punktstreifen so gross wie die Punkte in den Streifen. Länge 10 bis 11 mm. Dunkelbraun, Abdomen und Flügeldecken schwärzlich rotbraun, Beine gelbbraun. Fühler kräftig, 4. Glied länger als das 3., etwas stärker; Augenabstand halb Durchmesser. Halsschild so lang wie breit. Schenkel stark keulig; Vorderschienen mit Geschlechtsmerkmalen (Männchen). Mindanao und Samar.
A. fortepunctata sp. nov.

12 (11) Punkte viel feiner.

13 (14) Fühler auffallend dünn, 5. bis 10. Glied länger als das 4. Länge 10 mm. Pechschwarz, Beine etwas heller, besonders die Schienenspitzen, Tarsen gelbbraun, Mundteile, Fühler besonders in der zweiten Hälfte rotbraun, Flügeldecken schwarzbraun. Fühler sehr dünn, mehr als zwei Drittel der Körperlänge, 4. Glied fast so lang wie das 1. bis 3. zusammen; Augenabstand fast ein Durchmesser. Halsschild leicht quer, ziemlich grob und dicht punktiert. Zwischenräume gewölbt, nahe den Punktstreifen äusserst fein punktiert. Penang .... *A. leptocera* sp. nov.

14 (13) Fühler von gewöhnlicher länge und Stärke.

15 (24) Beine mit ungewöhnlich langer Behaarung.

16 (19) Schenkel und Schienen lang, abstehend beborstet.

17 (18) Halsschild glockenförmig. Länge 7 bis 8 mm. Schwärzlich rotbraun, Abdomen heller, Beine, Fühler und oft der Vorderkopf gelblich, Schenkelspitzen oft angedunkelt, Flügeldecken von gelblichbraun bis pechschwarz. Fühler fadenförmig, beim Männchen fast drei Viertel der Körperlänge, 3. und 4. Glied gleich. Halsschild so lang wie breit. Zwischenräume der Punktstreifen gewölbt, fein raspelartig punktiert. Singapore.
A. macer sp. nov.

18 (17) Grösste Breite des Halsschildes vor der Mitte. Länge 6.5 mm. Ziemlich schlank, doppelt behaart; schwarzlich rotbraun, Hinterleib gegen die Spitze heller, Beine und Fühler gelblich, Flügeldecken gelblichbraun, ein Tier von Borneo hat oben und innen angedunkelte Schenkel und dunkelrotbraune Flügeldecken. Drittes Fühlerglied etwas länger als das 4.; Augenabstand halb Durchmesser. Halsschild so lang wie breit, mit ziemlich dich-

ten, groben Augenpunkten. Zwischenräume mit ziemlich dichter, feiner, etwas unordentlicher Borsten punktreihe. Basilan und Borneo .... *A. hirtipes* sp. nov.

19 (16) Nur die Hinterschienen lang abstehend beborstet.

20 (23) Käfer grösser: etwa 11 bis 14 mm.

21 (22) Die Punkte auf den Zwischenräumen bilden feine Querrunzeln. Länge 14 mm. Flügeldecken schwarz behaart; Halsschild und Flügeldecken mit einzelnen längeren aufrechten Haaren; schwarz, Beine und Fühler, Vorderkopf und Mundteile rotbraun, zweite Schenkelhälfte besonders auf der Oberseite dunkel. Fühler länger als der halbe Körper, 3. und 4. Glied gleich; Augenabstand halb Durchmesser; Halsschild leicht quer, mit groben Augenpunkten. Mindanao .... *A. surigaoana* sp. nov.

22 (21) Die Punkte bilden keine Querrunzeln. Länge 11.5 mm. Schlank; Oberseite mit einzelnen längeren, aufrechten Borsten; pechschwarz, Mundteile und die zwei Grundglieder der Fühler und die Füsse braun. Fühler ziemlich kräftig, 3. und 4. Glied gleich; Augenabstand ein Viertel Durchmesser. Halsschild glockenförmig, etwas quer, mit groben Augenpunkten. Singapore. *A. singaporensis* sp. nov.

23 (20) Käfer bis 10 mm. Länge 9 bis 10 mm. Schmal; Halsschild am Rande mit längeren aufrechten Borsten; heller oder dunkler rotbraun, Hinterleib meist heller, Vorderkopf, Fühler und Mundteile meist gelbbraun, immer heller als die Unterseite, Flügeldecken an den seiten mehr oder weniger breit dunkel, selten ganz geschwärzt. Fühler fast drei Viertel Körperlänge, 3. Glied wenig kürzer als das 4.; Augenabstand halb bis ein Viertel Durchmesser. Halsschild so lang wie breit, mit groben Augenpunkten. Mindanao und Basilan............ *A. longicornis* sp. nov.

24 (15) Beine nur mit der gewöhnlichen, halb abstehenden Behaarung.

25 (34) Käfer grösser als 6 mm.

26 (27) Vorderschienen des Männchens mit zahnartiger Erweiterung am Ende des ersten Drittels. Länge 13 mm. Pechbraun, Beine, Fühler, Mundteile und Flügeldecken etwas heller. Augenabstand etwas weniger als ein Durchmesser; Fühler nach aussen dünner, zwei Drittel der Körperlänge, 3. Glied so lang wie das 4.; Halsschild drei Viertel so lang wie breit, mit groben Augenpunkten. Punktstreifen der Flügeldecken vorn grob, Zwischenräume undicht, unregelmässig, fein punktiert. Borneo. *A. borneensis* Pic.

27 (26) Vorderschienen des Männchens nur gekrümmt, sonst ohne Geschlechtsmerkmale.

28 (31) Fühler deutlich länger als der halbe Körper.

29 (30) Zwischenräume der Punktstreifen ziemlich dicht, sehr fein, raspelartig punktiert. Länge 14 bis 14.5 mm. Kopf und Halsschild mit einigen längeren aufrechten Borsten; pechschwarz, Spitzen der Schienen, Füsse, Mundteile, Vorderkopf und Fühler heller oder dunkler braun. Fühler dünn, 3. und 4. Glied gleich; Augen sehr gross, Abstand (Männchen) ein Viertel Durchmes-

ser; Halsschild so lang wie breit, mit starken Augenpunkten. Punktstreifen vorn grob, Zwischenräume leicht gewölbt. Sibuyan .... *A. densepunctata* sp. nov.

30 (29) Zwischenräume viel weniger dicht punktiert, Käfer kleiner. Länge 11.5 mm. Schlank; pechschwarz, Schienen, Füsse, Mundteile und Fühler (besonders gegen die Spitze) mehr rotbraun, Flügeldecken schwarzbraun. Fühler etwa zwei Drittel der Körperlänge, ziemlich dünn, 3. und 4. Glied gleich; Halsschild so lang wie breit, mit starken Augenpunkten. Augenabstand halb Durchmesser. Punktstreifen vorn grob; Zwischenräume sehr fein und zerstreut punktiert, ziemlich dicht, mässig lang, halb abstehend behaart. Borneo .... *A. villosa* sp. nov.

31 (28) Fühler kürzer.

32 (33) Beine rotbraün, Halsschild meist deutlich quer. Länge 9 bis 9.5 mm. Wenig gestreckt; schwarzbraun, Abdomen gegen die Spitze heller, Beine gelbbraun, Vorderkopf, Fühler und Mundteile rotbraun, Flügeldecken zuweilen gegen die Spitze heller; Fühler kaum halb so lang wie der Körper, mittelstark, Glieder lang und schwach dreieckig, 4. Glied kaum kürzer als das 3.; Augenabstand zwei Drittel Durchmesser. Halsschild so lang wie breit oder wenig kürzer, mit dichten, groben Augenpunkten. Punktstreifen vor grob, Zwischenräume mit sehr feinen, neben den Streifen fast gereihten, in der Mitte spärlichen Borstenpunkten. Mindanao und Basilan .... *A. fortipes* sp. nov.

33 (32) Beine schwarz, Halsschild so lang wie breit. Länge 9.5 mm. Pechschwarz, Flügeldecken schwarzbraun, Vorderrand der Oberlippe und des Clypeus braun; Schienen innen länger, fuchsrot behaart, aussen lang abstehend schwarz. Augenabstand halb Durchmesser; 5. Fühlerglied kaum kürzer als das 4.; Beine kräftig, Vorder- und Mittelschienen mässig gebogen; Analsegment nicht ausgerandet. Borneo........................ *A. affinis* sp. nov.

34 (25) Käfer nur 4.5 bis 5.5 mm. Mässig gestreckt, jeder Zwischenraum der Punktstreifen mit einer Reihe halb aufstehender, ziemlich langer, heller Haare, Borstenpunkte des Halsschildes mit je einer anliegenden hellen Borste; heller oder dunkler braun bis pechschwarz, Flügeldecken meist heller mit dunklerer Naht, Fühler hellbraun, jedes Glied an der Spitze dunkler, Beine gelblichbraun, Schenkel in der zweiten Hälfte etwas, Hinterschenkel viel dunkler. Fühler schlank, fast die Körpermitte erreichend, 4. Glied fast doppelt so lang wie das 3.; Augenabstand etwa halb Durchmesser. Halsschild meistens so lang wie breit, mit dichten groben Augenpunkten. Flügeldecken hinter dem ersten Viertel leicht quer eingedrückt, Punktstreifen stark, Punkte grob, Zwischenräume gewölbt, gegen die Spitze fast kielförmig. Beine mit stark keuligen Schenkeln. Analsegment des Männchens in der Mitte mit einer glatten dreieckigen Erhöhung, deren Spitze nach vorn zeigt; nur das vorletzte Tarsenglied der Füsse lappig erweitert. Luzon, Mindanao, Basilan, Penang, und Borneo. *A. minuta* Pic.

BESCHREIBUNGEN

ALLECULA TENUEPUNCTATA sp. nov.

Länge 11 mm. Ziemlich schlank, gewölbt, mässig glänzend, Halsschild und Flügeldecken durch mikroskopische Grundskulptur bläulich seidenglänzend; kurz, fast anliegend gelbbraun, Unterseite etwas dichter behaart; pechbraun, Vorderkopf und Fühler heller, Flügeldecken dunkel rotbraun. Kopf fein und ziemlich dicht punktiert; Oberlippe stark querherzförmig, wenig gewölbt, kräftig ausgerandet; Clypeus ziemlich stark quer, wenig gewölbt, nach vorn etwas verengt, von der Stirn durch eine feine, gebogene Linie getrennt; Stirn gewölbt, vorn eingedrückt; Schläfen sehr kurz, plötzlich verengt; Halsfurche deutlich; Endglied der Kiefertaster innen viel stärker erweitert, der Lippentaster länglich beilförmig; Fühler dünn, fadenförmig, die Körpermitte überragend, 3. Glied fast doppelt so lang wie das 1. und 2. zusammen, 4. deutlich länger als das 3., folgende Glieder etwas kürzer werdend, 11. etwas kürzer als das 10., leicht gebogen, schräge zugespitzt; Augen stark gewölbt, nicht schmal, Abstand fast ein Durchmesser. Halsschild drei Viertel so lang wie breit, viel breiter als der Kopf, gewölbt, fein und dicht punktiert, Eindrücke schwach, Seiten fast parallel, fein, herabgebogen gerandet, im letzten Viertel gerundet verengt, Apex zwei Drittel der Basis, ziemlich breit, aber flach gerandet. Schildchen zungenförmig, mit schwacher Mittelleiste, sehr fein punktiert. Flügeldecken kaum ein Viertel breiter als die Halsschildbasis, von der Basis bis zur Spitze schwach gerundet verengt, Punktstreifen vertieft, Punkte rund, vorn ziemlich grob, nach hinten fein, Punkte durch eine feine, glänzende Linie verbunden; Zwischenräume gewölbt, sehr fein, nicht dicht punktiert; Epipleuren vorn neben dem Innenrande mit einer einfachen Reihe starker, hinten sehr feiner Punkte. Beine mittlestark, Schienen wenig gebogen, Hinterschenkelspitze überragt den Hinterrand des 4. Segments, Hintertarsen nicht ganz so lang wie die halbe Schiene, Metatarsus so lang wie die folgenden Glieder zusammen; Lappung der Füsse 1.-4., 3.-4. 3. Glied; Analsegment flach, Hinterrand gerundet.

Ein Männchen von Süd-Celebes, Bantimurung, gesammelt von Dres. Sarasin, in meiner Sammlung.

Die Art gehört in die Gruppe *A. sericans* Fairm. Diese hat gerundete Halsschildseiten; die Zwischenräume der Punktstreifen sind nicht erkennbar punktiert, und die Vorderschienen haben Geschlechtsmerkmale. (Seihe die Bestimmungstabelle!)

ALLECULA SANDAKANA sp. nov.

Länge 10.5 mm. Ziemlich gestreckt, Flügeldecken von den Schultern bis zum Beginn des letzten Drittels fast geradlinig schwach, dann stärker, wenig gebogen verengt; wenig glänzend, mässig dicht, fein, ziemlich kurz, halb abstehend, fuchsrot, Unterseite mit Ausnahme der Schienen fein, dünn, ziemlich kurz, anliegend behaart; pechschwarz, Vorderkopf, Mundteile, Füsse und Fühler mehr dunkel rotbraun. Kopf ziemlich dicht, mittelstark punktiert; Oberlippe flach, stark ausgerandet; Clypeus stark quer, nicht verengt, ziemlich fein und dicht punktiert; Stirn etwas beulig gewölbt; Schläfen so lang wie ein halbes Auge; Halsfurche deutlich; Mundteile normal; Fühler ziemlich dünn, fadenförmig, fast zwei Drittel der Körperlänge, 1. Glied geschwollen, so lang wie breit, 2. ein Drittel so lang, 3. doppelt so lang wie 1. und 2. zusammen, so lang wie das 4., folgende Glieder kürzer werdend, 11. gegen die Spitze etwas verbreitert, plötzlich zugespitzt, etwa halb so lang wie das 3., etwas kürzer als das 10.; Augen stark gewölbt, Abstand ein Durchmesser. Halsschild zwei Drittel so lang wie breit, mässig gewölbt, mit starken, dichten Augenpunkten, mit sehr feiner Grundskulptur, Seiten fast parallel bis zum Anfang des letzten Viertels, dann gerundet verengt, Basis kräftig gerandet, Seiten neben den Basisecken breit und flach ausgerandet, scharf, herabgebogen gerandet, Apex zwei Drittel so breit wie die Basis, sehr fein gerandet, hinter den Augen schwach ausgeschnitten, Basiswinkel rechteckig, kurz abgerundet. Schildchen zungenförmig, fein punktiert. Flügeldecken ein Viertel breiter als die Halsschildbasis, durch mikroskopische Grundskulptur schwach seidenglänzend; Punktstreifen kräftig, mässig vertieft, Punkte durch glatte Linien mit einander verbunden, in der Spitze feiner; Zwischenräume mässig, in der Spitze wenig stärker gewölbt, mit vielen feinen, mässig dichten, unregelmässig gestellten Borstenpunkten; Epipleuren vorn mässig breit, schnell verengt, Punktreihe am Innenrande vorn nicht stärker als die Punkte in den Streifen. Unterseite vorn grob und dicht, hinten sehr fein und sehr dicht punktiert; Schenkel ziemlich stark keulig, Schienen wenig gebogen, die Hinterschenkelspitze überragt bedeutend den Hinterrand des 4. Segments; Metatarsus der Hinterfüsse so lang wie die folgenden Glieder zusammen, Hinterfüsse halb so lang wie die Schiene. Lappung der Füsse 2.-4., 2.-4., 3. Glied.

BORNEO, Sandakan, 1 Exemplar, Nr. 15823, gesammelt von Prof. C. F. Baker, in meiner Sammlung.

Die Art ist verwandt mit *A. sericans* Fairm.; aber sie ist kleiner; ihr Halsschild ist stark punktiert und etwas viereckig, an den Seiten nicht gerundet erweitert, sondern in der ersten. Hälfte sehr flach ausgerandet. Diese Halsschildform unterscheidet die Art auch von *A. dentipes* Bm. und *A. pachyscelis* m.

ALLECULA PACHYSCELIS sp. nov.

Länge 11.5 bis 14 mm. Sehr ähnlich *A. dentipes* m., aber etwas breiter und gewölbter; wenig glänzend; Oberseite mittellang, halb abstehend, Unterseite sehr fein, kurz, undicht, Beine sehr dicht, anliegend, Schienen länger behaart; pechschwarz, Füsse, Endglied der Kiefertaster und die Fühler in der zweiten Hälfte heller. Kopf grob und ziemlich dicht punktiert; Oberlippe stark quer, wenig gewölbt, ausgerandet; Clypeus gewölbt, von den Wangen nach vorn deutlich erweitert, Gelenkhaut breit, Stirn eingedrückt; Schläfen halb so lang wie ein Auge; Halsfurche sehr deutlich; Mundteile normal, Endglied der Kiefertaster mit ungleichen Seiten; äussere so lang wie die vordere, innere deutlich kürzer; Fühler fadenförmig, zwei Drittel so lang wie der Körper, 1. Glied geschwollen, über zwei mal so lang wie breit, 2. ein Drittel so lang, leicht quer, 3. doppelt so lang wie das 1., leicht gebogen, nach vorn verdickt, deutlich kürzer als das 4., alle folgenden Glieder gegen die Spitze etwas verdickt, unter sich gleich, 11. etwas dünner und wenig kürzer als das 10.; Augen schmal, stark ausgerandet, Abstand etwas mehr als ein halber Durchmesser. Halsschild so lang wie breit, mässig gewölbt, wie die Flügeldecken mit feiner Grundskulptur, fast matt, mit dichten, groben Augenpunkten, Seiten von der Basis an bis zum Beginn des letzten Drittels schwach, fast geradlinig, dann schnell starker gerundet verengt, Basis in der Mitte mit kurzer, flacher, breiter Mittelfurche, vor den Ausbuchtungen je eine flache Grube, mässig breit, Seiten und Apex sehr fein gerandet, Apex hinter den Augen leicht ausgebuchtet, Basiswinkel fast rechteckig, kurz gerundet. Schildchen quer zungenförmig, mit Mittelfurche, glänzend, fein punktiert. Flügeldecken nicht ganz um die Hälfte breiter als die Halsschildbasis, die mikroskopische Grundskulptur erzeugt einen schwachen bläulichen Seidenglanz; Punktstreifen stark, tief, Punkte rund, vorn sehr dicht, in der Spitze viel feiner; Zwischenräume ziemlich gewölbt, besonders in der Spitze und an den Seiten, jeder mit zwei etwas unordentlichen, den Punktstreifen genäherten feinen Borstenpunktreihen; Epipleuren vorn breit und vertieft, schnell verengt, neben dem inneren Rande sehr grobe, hinten feinere Punkte;

Spitzen einzeln kurz zugespitzt. Unterseite und Beine wie bei *A. decipiens* m. ohne Geschlechtsmerkmal (Weibchen); Hinterschenkelspitze erreicht nicht den Hinterrand des 4. Segments; Metatarsus der Hinterfüsse wenig länger als die zwei folgenden Glieder zusammen; Analsegment einfach; Lappung der Füsse 1.-4., 2.-4., 4. Glied.

BASILAN, 1 Weibchen, Nr. 15812, gesammelt von Prof. Baker, Weibchen von selben Fundort von Böttcher in weiner Sammlung. Die dicken Vorderschenkel des Weibchens lassen auf Geschlechtsmerkmale an den Beinen der Männchen schliessen.

Die Art ist nahe verwandt mit *A. dentipes* m. und *sericans* Fairm. Die letzte hat ziemlich stark queren, äusserst fein punktierten Halsschild; die Zwischenräume auf den Flügeldecken werden in der Spitze flacher, die Spitzen sind einzeln gerundet, und die Vorderschenkel sind viel schwächer. Bei *A. dentipes* ist der Halsschild zwar fein, aber deutlich, wenig dicht punktiert, die Borstenpunkte der Zwischenräume sind mehr über den ganzen Raum verteilt, und die Flügeldeckenspitzen sind kurz einzeln gerundet. Vielleicht ist diese Art nur das Weibchen von *A. dentipes* m.

ALLECULA DENTIPES sp. nov.

Länge 11 bis 12 mm. Schlank, mässig gewölbt, matt, mit sehr dichter und äusserst feiner Grundskulptur, die dem Tiere einen bläulichen Seidenschimmer verleiht; undicht, ziemlich lang, halb abstehend, hellbraun behaart; pechschwarz, Schenkel dunkelbraun, Schienen, Fühler, Vorderkopf und Mundteile rotbraun. Kopf ziemlich kurz, sehr dicht und grob punktiert; Oberlippe stark quer herzförmig, fast flach; Clypeus so lang wie breit, wenig gewölbt, von der Stirn normal getrennt; Stirn vorn eingedrückt; Schläfen sehr kurz; Hals stark abgeschnürt, feiner punktiert; Endglied der Kiefertaster breit, gleichschenklig dreieckig; Augen normal, Abstand ein Drittel Durchmesser; Fühler länger als der halbe Körper, fadenförmig, 1. Glied etwas geschwollen, dreimal so lang wie an der Spitze breit, 2. ein Viertel des 1., so lang wie breit, 3. leicht gebogen, an der Spitze verdickt, so lang wie das 1. und 2. zusammen, 4. so lang wie das 2. und 3. zusammen, folgende Glieder unter sich gleich, 11. gebogen, zugespitzt, etwas kürzer als das 10.; Halsschild etwas länger als breit, gewölbt, undicht, mittelstark, flach punktiert, um die Hälfte breiter als der Kopf, Seiten von der Basis bis zum Anfang des letzten Drittels fast gerade, sehr wenig verengt, dann gerundet verengt, Apex zwei Drittel der Basis, an der

Basis eine kurze, seichte Längsfurche und jederseits ein flacher Eindruck vor der Ausbuchtung, alle Seiten fein gerandet, Seitenrand von oben nicht sichtbar, Basisecken etwas stumpf, kurz abgerundet. Schildchen kurz zungenförmig, glänzend, fein punktiert. Flügeldecken ein Drittel breiter als die Halsschildbasis, von den Schultern ab schwach verengt; Punktstreifen kräftig, vertieft, Punkte rund, gegen die Spitze feiner; Zwischenräume ziemlich gewölbt, mit weitläufigen, unordentlichen Borstenpunktreihen; Schultern, Spitzen und Epipleuren normal. Unterseite vorn grob, hinten sehr fein und dicht punktiert und ziemlich dicht, anliegend, hell behaart. Beine kräftig, Schenkel keulig, Hinterschenkelspitze erreicht den Hinterrand des 4. Segments, Vorderschenkel in der ersten Hälfte an der Innenseite breit ausgeschnitten, Vorderschienen innen in der Mitte mit einem starken, breiten Zahne, Mittelschienen mässig, Hinterschienen schwach gebogen; an den Vorderfüssen das 1. bis 4., an den Mittelfüssen das 2. bis 4., an den Hinterfüssen das 3. Glied lappig erweitert; Analsegment am Hinterrande gerundet, vor dem Rande eine breite, flache, runde Grube.

MINDANAO, Iligan (*Baker*) Nr. 15813, Kolambugan (*Baker*), und Dapitan (*Baker*), 3 Männchen in meiner Sammlung.

Auf den ersten Blick gleicht die Art der *A. sericans* Fairm.; aber diese ist plumper. Ihr Halsschild ist quer; ihre Augen sind viel weniger ausgerandet; das 3. Fühlerglied ist ebenso lang wie das 4., und der Zahn an den Vorderschienen des Männchen ist viel schwächer. Das Analsegment ist fast gerade abgestutzt und zeigt keine Grube.

ALLECULA FORTEPUNCTATA sp. nov.

Länge 10 bis 11 mm. Gestreckt, mässig gewölbt, mässig glänzend; etwas rauh, halb anliegend, mässig dicht, hell behaart, Unterseite kurz, fein, anliegend, Schienen kaum länger behaart; dunkelbraun, Abdomen und Flügeldecken schwärzlich rotbraun, Beine gelbbraun. Oberlippe quer herzförmig, wenig gewölbt, schwach ausgerandet; Clypeus leicht quer, schwach gewölbt, dicht und stark punktiert; Stirn vorn eingedrückt, grob und dicht punktiert; Schläfen ein Viertel Augendurchmesser; Halsfurche sehr seicht; Endglied der Kiefertaster sehr breit, beide Spitzen gleich, Endglied der Lippentaster dreieckig; Fühler mittel (Glied 7 bis 11 fehlen), 3. Glied etwas länger als das 1. und 2. zusammen, leicht gebogen, 4. stärker, deutlich länger, 5. und 6. Glied wenig kürzer, unter sich gleich; Augen stark gewölbt, breit. Abstand halb Durchmesser. Halsschild so lang

wie breit, ein Viertel breiter als der Kopf, mit sehr groben, dichten Augenpunkten, Mittelfurche breit, vollständig, flach, Basis normal, Seiten nahe der Basis seicht und breit ausgerandet, bis zur Mitte sehr wenig, dann schneller gerundet verengt, fein herabgebogen gerandet, Apex etwas länger als die halbe Basis, in der Mitte ungerandet. Schildchen quer zungenförmig, fein punktiert. Flügeldecken bis zum letzten Drittel sehr wenig, dann schneller gerundet verengt, Punktstreifen vertieft, Punkte rund, vorn grob und dicht, hinten schwindend; Zwischenräume mässig gewölbt, sehr dicht, ziemlich grob punktiert, Punkte so gross wie die der Punktstreifen, ebenfalls Augenpunkte; Epipleuren vorn breit, schnell verengt, etwas ausgehöhlt, ausser der vorderen groben Punktierung sehr fein querrunzelig, raspelartig punktiert. Unterseite normal. Schenkel stark keulig, Vorderschienen innen in der Mitte mit seichter, stumpfer, breiter Erhöhung, gegen die Spitze verdickt und breit ausgehöhlt, Hinterschienen zweimal gebogen, zweite Hälfte an der Innenseite breit erweitert, Hinterschenkel überragen den Hinterrand des 4. Segments; Hintertarsen halb so lang wie die Schiene, Metatarsus kürzer als die folgenden Glieder zusammen; Analsegment am Hinterrande stark gerundet; Lappung der Füsse 1.-4., 2.-4., 2.-3. Glied.

MINDANAO, Iligan, und SAMAR, 2 Männchen von Prof. Baker gesammelt, in meiner Sammlung.

Die Art ähnelt den grossen *Alleculodes*-Arten; aber das Endglied der Lippentaster ist nicht ausgerandet. Sie unterscheidet sich von allen mir bekannten Arten durch die eigenartige Flügeldeckenskulptur (Augenpunkte).

ALLECULA LEPTOCERA sp. nov.

Länge 10 mm. Form gewöhnlich; mässig gewölbt; halb anliegend, ziemlich kurz, undicht bräunlich behaart, Haare des Halsschildes sehr dicht, anliegend; ziemlich glänzend; pechschwarz, Beine etwas heller, besonders die Schienenspitzen, Tarsen gelbbraun, Mundteile, Fühler besonders in der zweiten Hälfte rotbraun, Flügeldecken schwarzbraun. Kopf dicht, ziemlich grob punktiert; Oberlippe stark querherzförmig, wenig gewölbt; Clypeus nicht verengt, stärker gewölbt, Gelenkhaut breit; Stirn schwach gewölbt, vorn der Länge nach eingedrückt; Schläfen sehr kurz; Hals kaum abgeschnürt; Endglied der Kiefertaster breit, Innenseite zwei Drittel so lang wie die Aussenseite, Endglied der Lippentaster stark nach innen erweitert; Fühler mehr

als zwei Drittel der Körperlänge, sehr dünn, fadenförmig, 1. Glied zwei und ein halb mal so lang wie breit, 2. kaum ein Drittel so lang, 3. länger als 1. und 2. zusammen, 4. fast so lang wie Glied 1 bis 3 vereinigt, folgende Glieder immer dünner, unter sich gleich, 11. schwach gebogen, gegen die Spitze dicker, zugespitzt, etwas kürzer als das 10.; Augenabstand fast ein Durchmesser; Halsschild leicht quer, mässig gewölbt, ziemlich grob und dicht punktiert, Basiseindrücke normal, vor der Basis quer, sehr schwach und breit eingedrückt, Basis gerandet, Ecken fast rechtwinklig, Seiten fein, herabgebogen gerandet, von der Basis bis zur Mitte sehr schwach nach vorn verengt, fast gerade, dann gerundet verschmälert, Apex in der Mitte ungerandet, etwa zwei Drittel der Basis. Schildchen quer zungenförmig, sehr fein punktiert, mit breiter, flacher Mittelfurche. Flügeldecken fast um die Hälfte breiter als die Halsschildbasis, im ersten. Viertel stark gewölbt, bis zum letzten Viertel fast parallel, dann gerundet verengt, Punktstreifen vertieft, Punkte vorn breit, grob, dicht, hinten viel feiner; Zwischenräume gewölbt, in der Spitze und an den Seiten stärker, nahe den Punktstreifen äusserst fein punktiert; Spitzen zusammen gerundet; Epipleuren vorn breit, schnell verengt, vorn neben dem Innenrande sehr grob, hinten sehr fein punktiert. Unterseite normal; Beine ziemlich kurz, Schenkel ziemlich dick, fein und dicht punktiert und behaart, Vorder- und Mittelschienen gebogen, Hinterschienen gerade; Spitze der Hinterschenkel erreicht den Hinterrand des 3. Segments, Hintertarsen kaum halb so lang wie die Schiene, Metatarsus der Hinterfüsse etwas kürzer als die folgenden Glieder zusammen. Lappung der Füsse 1.-4., 3. und 4., 3. Glied.

PENANG, Nr. 15815, gesammelt von Prof. Baker, 1 Weibchen in meiner Sammlung.

Die Art ist mit *A. cuneipennis* Fairm. verwandt, ist aber viel kleiner und viel schwächer behaart. Ihre Fühler sind viel dünner und länger. Bei *A. cuneipennis* sind die Zwischenräume der Punktstreifen ziemlich dicht und sehr deutlich punktiert; die Vorderfüsse haben nur zwei Lamellen. *A. suturalis* m. ist anders gefärbt; die Fühler sind kürzer und stärker; die Zwischenräume sind viel stärker und dicht punktiert; die Mundteile sind anders.

ALLECULA MACER sp. nov.

Länge 7 bis 8 mm. Sehr ähnlich der *A. hirtipes* m. Schwärzlich rotbraun, Abdomen heller, Beine, Fühler und oft der Vorderkopf gelblich, Schenkelspitzen zuweilen angedunkelt,

Flügeldecken von gelblichbraun bis pechschwarz; mässig glänzend; Oberseite ziemlich dicht, mässig lang, halb abstehend, gelblich behaart. Oberlippe stark quer, fast flach, ziemlich kräftig und dicht punktiert, wenig ausgerandet; Clypeus stark quer, nicht verengt, von der Stirn scharf abgesetzt; Stirn eingedrückt, grob, etwas längsrissig punktiert; Schläfen halb so lang wie ein Auge; Halsfurche scharf; Endglied der Kiefertaster nach innen etwas stärker erweitert, der Lippentaster dreieckig; Fühler schlank, gegen die Spitze etwas dünner, fadenförmig, fast drei Viertel der Körperlänge, beim Weibchen etwas kürzer, 3. Glied um die Hälfte länger als das 1. und 2. zusammen, so lang wie das 4., 5. und die folgenden Glieder etwas kürzer, unter sich gleich, 11. dünn, sehr spitz, etwas gebogen, wenig kürzer als das 10.; Augen stark gewölbt, Abstand halb Durchmesser, beim Weibchen etwas mehr. Halsschild sehr deutlich breiter als der Kopf, so lang wie breit, leicht glockenförmig, mässig gewölbt, mit sehr groben, ziemlich dichten Augenpunkten, Basiseindrücke sehr schwach, Seiten mit gewöhnlicher Randung, Apex etwas länger als die halbe Basis, fein gerandet. Schildchen breit zungenförmig. Flügeldecken ein Drittel breiter als die Halsschildbasis, vorn wenig gewölbt, nach dem ersten Viertel leicht erweitert, dann sehr schwach gerundet verengt, Punktstreifen vorn grob, leicht quer, hinten sehr fein, vertieft; Zwischenräume gewölbt, undicht, unregelmässig, fein raspelartig punktiert; Schultern, Spitzen und Epipleuren normal. Unterseite vorn grob, hinten viel feiner und undichter punktiert; Beine wenig stark, Schienen lang beborstet, Hinterschenkel erreichen fast den Hinterrand des letzten Segments, beim Weibchen kürzer; Vorder- und Mittelschienen mässig gebogen, Hinterfüsse viel kürzer als die halbe Schiene, beim Weibchen etwas länger, Metatarsus kürzer als die drei folgenden Glieder zusammen; Analsegment an der Spitze gerundet; Lappung der Füsse M.-4., 3.-4., 3. Glied.

SINGAPORE, von Prof. Baker gesammelt (Nr. 15816), 4 Männchen und Weibchen in meiner Sammlung.

Die Art ist der *A. hirtipes* m. sehr ähnlich, ist aber kleiner. Ihr Halsschild ist glockenförmig und viel gröber punktiert; die Beine sind schwächer, die Zwischenräume dichter punktiert.

ALLECULA HIRTIPES sp. nov.

Länge 6.5 mm. Ziemlich schlank, wenig gewölbt, mässig glänzend; doppelt behaart; mässig dicht, ziemlich lang, halbabstehend, gelblich und länger, spärlicher, aufrecht, Unter-

seite kürzer, feiner, undichter, anliegend, Beine ausser der gewöhnlichen Behaarung mit undichten, lang abstehenden Borsten; schwärzlich rotbraun, Hinterleib gegen die Spitze heller, Beine und Fühler gelblich, Flügeldecken gelblich braun. Ein Tier von Borneo hat oben und innen angedunkelte Schenkel, die Flügeldecken sind dunkel rotbraun. Oberlippe stark querherzförmig, wenig gewölbt, stark ausgerandet, fein punktiert; Clypeus quer, wenig gewölbt, von der Stirn durch eine scharfe, wenig gebogen Furche getrennt; Stirn wenig gewölbt, vorn leicht eingedrückt, ziemlich fein, etwas undicht punktiert; Schläfen kurz; Halsfurche deutlich; Endglied der Kiefertaster aussen wenig, innen stark erweitert; Fühler dünn, fadenförmig, (Glied 9 bis 11 fehlen), 3. Glied um die Hälfte länger als das 1. und 2. zusammen, etwas länger als das 4., folgende Glieder unter sich gleich; Augen stark gewölbt, breit, Abstand kaum ein halber Durchmesser. Halsschild wenig breiter als der Kopf mit den Augen, so lang wie breit, sehr mässig gewölbt, mit ziemlich dichten, groben Augenpunkten, in der Mitte der Basis breit und flach eingedrückt, die andern Eindrücke sehr seicht, Seiten bis zum Anfang des letzten Drittels fast gerade, kaum verengt, dann gerundet zusammengezogen, Apex in der Mitte kaum gerandet. Schildchen kurz zungenförmig. Flügeldecken kaum ein Drittel breiter als die Halsschildbasis, in der Mitte am breitesten, im ersten Viertel schwach eingezogen, vorns sehr wenig gewölbt, Punktstreifen kräftig, vertieft, Punkte vorn rund, ziemlich dicht, in der Spitze sehr fein und weitläufig; Zwischenräume mässig gewölbt, jeder mit einer ziemlich dichten, etwas unordentlichen, feinen Borstenpunktreihe; Epipleuren und Spitzen normal. Unterseite vorn grob und ziemlich dicht, hinten stark und zerstreut punktiert, Analsegment an der Spitze abgerundet; Beine kräftig, Schenkel ziemlich keulig, Hinterschenkelspitze erreicht nicht ganz den Hinterrand des 5. Segments, Schienen wenig gebogen, am stärksten die Mittelschienen, Hintertarsen halb so lang wie die Schiene, Metatarsus so lang wie die folgenden Glieder zusammen; Lappung der Tarsen: 3.-4., 3.-4., 3. Glied.

BASILAN (*15819*) und BORNEO, Sandakan, gesammelt von Prof. Baker, 2 Männchen in meiner Sammlung.

Die Art ist nahe verwandt mit *A. longicornis* m., ist aber kleiner. Ihre Beine sind stärker gekeult und viel länger behaart. Die Zwischenräume der Punktstreifen sind viel spärlicher punktiert und die Punkte anders angeordnet.

ALLECULA SURIGAOANA sp. nov.

Länge 14 mm. Mässig gestreckt, gewölbt, ziemlich glänzend; Halsschild mässig kurz, halb anliegend, braun, Flügeldecken ebenso schwarz behaart, Halsschild und Flügeldecken (besonders vorn) mit vereinzelten, längeren, aufrechten Haaren, Unterseite fein, anliegend, Schienen länger, abstehend hell behaart; schwarz, Beine und Fühler, Vorderkopf und Mundteile rotbraun, zweite Schenkelhälfte besonders auf der Oberseite dunkler. Kopf mässig stark, ziemlich dicht punktiert; Oberlippe stark querherzförmig, kräftig ausgerandet, fast flach, fein und dicht punktiert; Clypeus so lang wie breit, ziemlich gewölbt; Schläfen äusserst kurz; Stirn schwach gewölbt, vorn flach eingedrückt; Halsfurche oben schwach; Endglied der Lippentaster beilförmig; Fühler ziemlich dünn, fast fadenförmig, gegen die Spitze dünner, länger als der halbe Körper, 3. Glied doppelt so lang wie das 1. und 2. zusammen, so lang wie das 4., 5. kaum ein Viertel kürzer, folgende Glieder unter sich gleich, 11. gebogen, zugespitzt; Augenabstand halber Durchmesser. Halsschild um die Hälfte breiter als der Kopf, leicht quer, gewölbt, mit groben, ziemlich dichten Augenpunkten, Basis normal, Seiten von der Basis bis zum Anfang des letzten Drittels sehr wenig, dann schneller gerundet verengt, fein, herabgebogen gerandet, Apex etwas breiter als die halbe Basis, fein gerandet. Schildchen viereckig, sehr fein punktiert. Flügeldecken ein Viertel breiter als die Halsschildbasis, ziemlich gewölbt, von den Schultern bis zum letzten Drittel sehr wenig, dann schneller verengt, Punktstreifen in der Spitze stärker vertieft, Punkte rund, vorn grob, in der Spitze sehr fein; Zwischenräume gewölbt, undicht, unregelmässig, fein raspelartig punktiert; Schultern, Spitzen und Epipleuren normal. Abdomen stellenweise längsstrichelig; Beine kräftig, Hinterschenkel reichen bis zur Mitte des letzten Segments, Vorder- und Mittelschienen mässig gebogen, Vorderschienen am Ende des ersten Drittels mit einer schwachen, breiten Erhöhung, die übrigen zwei Drittel breit und sehr schwach ausgeschnitten; Hinterfüsse halb so lang wie die Schienen, Metatarsus so lang wie die folgenden Glieder zusammen; Analsegment abgestutzt, vor dem Hinterrande flach; Lappung der Füsse: 3.-4., 3.-4., 3. Glied.

MINDANAO, Surigao, gesammelt von Prof. Baker, 1 Männchen in meiner Sammlung, von Herrn K. G. Blair als *A. borneensis* Pic bestimmt, deren Beschreibung ich nicht auffinden kann.

Ich habe ein sehr ähnliches Tier von Borneo, das dunkelbraun ist mit helleren Flügeldecken. Die Vorderschienen haben am Ende des ersten Drittels einen kräftigen, spitzen Zahn; die Fühler sind dicker und kürzer; das Analsegment ist sehr leicht ausgerandet. Ich halte dies Tier für *A. borneensis* Pic.

ALLECULA SINGAPORENSIS sp. nov.

Länge 11.5 mm. Schlank, ziemlich glänzend; mässig lang, halb abstehend, ziemlich dicht bräunlich behaart, Oberseite mit einzelnen längeren, aufrechten Borsten, Unterseite fein, viel spärlicher, anliegend behaart, Schienen in der kürzeren Grundbehaarung mit zahlreichen, langen, abstehenden Borsten; pechschwarz, Mundteile und die zwei Grundglieder der Fühler und die Füsse braun, Lamellen gelbbraun; Oberlippe stark querherzförmig, wenig ausgerandet, dicht und ungleich stark punktiert; Clypeus stark quer, wenig gewölbt, dicht punktiert, von der Stirn scharf abgesetzt; Stirn vorn eingedrückt, stark und dicht punktiert; Schläfen äusserst kurz; Halsfurche tief und scharf; Endglied der Kiefertaster innen stärker erweitert, der Lippentaster dreieckig; Fühler ziemlich kräftig, fadenförmig, (Glied 6 bis 11 fehlen), 3. Glied mehr als doppelt so lang wie Glied 1 und 2 zusammen, leicht gebogen, so lang wie das 4., 5. drei Viertel so lang; Augen gross, stark gewölbt, Abstand ein Viertel Durchmesser; Halsschild glockenförmig, etwas quer, ein Viertel breiter als der Kopf, mit groben, ziemlich dichten Augenpunkten, Basiseindrücke kräftig, Scheibe hinter dem Apex quer, breit, flach eingedrückt, Basis linienförmig gerandet, Seiten vom Beginn des letzten Drittels schneller verengt, Randung normal, Apex wenig breiter als die halbe Basis. Schildchen kurz zungenförmig, fein punktiert. Flügeldecken von den Schultern an allmählich verengt, wenig gewölbt, am Beginn des zweiten Drittels flach und breit eingedrückt, Punktstreifen vertieft, kräftig, Punkte vorn stark und dicht, in der Spitze fein und sehr weitläufig; Zwischenräume gewölbt, mit vielen feinen, unregelmässigen Borstenpunkten; Spitzen kurz gerundet abgestutzt; Epipleuren vorn mit grober, einfacher Punktreihe; Abdomen ziemlich stark und dicht punktiert, Analsegment gerundet abgestutzt, flach; Beine mittelstark, lang, Hinterschenkelspitze erreicht fast den Hinterrand des letzten Segments, Schenkel mässig keulig, Schienen mässig gebogen, Hinterfüsse lange nicht halb so lang wie die halbe Schiene, Metatarsus so lang wie die folgenden Glieder zusammen; Lappung der Füsse: 2.-4., 3.-4., 3. Glied.

SINGAPORE, gesammelt von Prof. Baker, 1 Männchen in meiner Sammlung.

Die Art ist der *A. cuneipennis* Fairm. nicht unähnlich, ist aber schlanker, hat dünnere Fühler, viel stärker punktierten Halsschild und keine Geschlechtsmerkmale an den Beinen.

ALLECULA LONGICORNIS sp. nov.

Länge 9 bis 10 mm. Schmal, mässig gewölbt, mässig glänzend, von den Schultern an nach hinten allmählich verengt, Oberseite fein, anliegend, mittellang, nicht sehr dicht, bräunlichgelb behaart, Halsschild besonders nahe dem Rande mit weitläufigen, aufrechten längeren Borsten; heller oder dunkler rotbraun, Hinterleib meist heller, Vorderkopf, Fühler und Mundteile, meist hell gelbbraun, immer heller als die Unterseite, Flügeldecken an den Seiten mehr oder weniger breit dunkel, selten ganz geschwärzt. Kopf ziemlich breit, ziemlich dicht, mittelstark punktiert; Oberlippe wenig gewölbt, stark querherzförmig, feiner, zerstreut punktiert; Clypeus schwach quer, quer gewölbt, wenig verengt, durch eine scharfe Furche von den Wangen und der Stirn getrennt; Stirn quer gewölbt; Schläfen sehr kurz, mit einigen groben Borstenpunkten; Mundteile normal; Fühler fadenförmig, dünn, beim Männchen länger als drei Viertel des Körpers, beim Weibchen etwas kürzer, 1. Glied ein und ein halb mal so lang wie breit, 2. dünner, halb so lang, Glieder vom 3. an stark gestreckt, 3. doppelt so lang wie das 1. und 2. zusammen, wenig kürzer als das 4., folgende wenig kürzer, 11. leicht gebogen, etwas zugespitzt, wenig kürzer als das 10.; Augen normal, Stirnabstand ein Viertel bis halb Durchmesser. Halsschild so lang wie breit, an der Basis deutlich breiter als der Kopf mit den Augen, schwach glockenförmig mässig gewölbt, ziemlich dicht mit groben Augenpunkten besetzt, an der Basis mit kurzer Mittellinie, neben den Ecken im Rande jederseits ein kurzer flacher Eindruck, Basis fein gerandet und beidereseits flach ausgeschnitten, Seitenrand linienförmig, herabgebogen, Apex sehr fein gerandet, hinter den Augen sehr schwach ausgeschnitten und sehr schwach niedergedrückt, Vorderecken verrundet, Basisecken rechteckig, kurz abgerundet. Schildchen quer zungenförmig, fein und dicht punktiert. Flügeldecken mit starken, vertieften, hinten feiner werdenden Punktstreifen, Punkte in der Spitze undeutlich; Zwischenräume gewölbt, sehr fein raspelartig, wenig dicht punktiert, oberer Seitenrand der Epipleuren im ersten Drittel mässig verbreitert; Schultern kräftig, Epi-

pleuren vorn ziemlich schmal, am inneren Rande mit sehr grober, dichter, nach hinten feiner werdender Punktreihe. Unterseite vorn grob, auf dem Hinterleibe feiner, nicht dicht punktiert; Analsegment am Hinterrande fast gerade, mit abgerundeten Ecken, beim Weibchen Hinterrand abgerundet; Beine beim Männchen mit stark keuligen Schenkeln, Vorder- und Mittelschienen besonders gegen die Spitze gebogen, beim Weibchen Schenkel dünner, Schienen weniger gebogen, in beiden Geschlechtern die Schienen lang, halb abstehend, ziemlich dicht; gelbbraun beborstet; Metatarsus der Hinterfüsse länger als die zwei folgenden Glieder zusammen; an den Vorder- und Mittelfüssen ist das 4. Glied breit lappig erweitert.

MINDANAO, Surigao (*15821*), Butuan, Iligan (*15825, 15828*), Davao (*4245, 6683*), Kolambugan (*15822*), Tangkulan (15829). BASILAN (*15818*). Zwei und zwanzig Exemplare in meiner Sammlung, alle von Prof. Baker gesammelt. MINDANAO, Momungan, und LUZON, Damalon, von G. Böttcher gesammelt. Im United States National Museum 2 Tiere von Butuan (*4620, 4245*) von Prof. Baker gesammelt.

Die Art ähnelt der *A. cuneipennis* Fairm.; aber diese ist bedeutend grösser, abweichend gefärbt und ihre Beine sind ganz dunkel. *Allecula longicornis* m. hat keine ausgesprochenen Geschlechtsmerkmale an den Vorderschienen, ihre Oberlippe ist vorn nur schwach ausgerandet.

ALLECULA BORNEENSIS Pic.

Länge 13 mm. Mässig glänzend; mässig lang, anliegend, ziemlich dicht gelbbraun behaart; pechbraun, Beine, Fühler, Mundteile und Flügeldecken etwas heller. Kopf grob und dicht punktiert; Oberlippe stark querherzförmig, lang und dicht gelbbraun beborstet, stark ausgerandet; Clypeus schwach quer, Gelenkhaut breit; Stirn mässig gewölbt; Halsfurche deutlich; Schläfen sehr kurz; Endglied der Kiefertaster nach innen bedeutend stärker erweitert als nach aussen; Augen stark gewölbt, Abstand etwas weniger als ein Durchmesser; Fühler fadenförmig, nach aussen dünner, zwei Drittel der Körperlänge, 3. Glied doppelt so lang wie das 1. und 2. zusammen, ebenso lang wie das 4., folgende Glieder wenig kürzer, Endglied dünn, gebogen, spitzt, so lang wie das 10. Halsschild drei Viertel so lang wie breit, gewölbt, mit groben, wenig dichten Augenpunkten, Apex sehr fein gerandet, Scheibe mit den gewöhnlichen Eindrücken, Seiten neben der Basis leicht ausgerandet, vom Beginn des letzten Drittels an gerundet verengt, Basiswinkel kurz ge-

rundet rechteckig. Schildchen normal. Flügeldecken von den Schultern ab bis zum letzten Fünftel allmählich verengt, Punktstreifen vertieft, vorn grob, hinten feiner punktiert, Zwischenräume gewölbt, undicht, unregelmässig fein punktiert; Spitzen zusammen gerundet; Vorderkörper unten grob, Hinterleib feiner punktiert; Beine kräftig, Vorderschienen gebogen, am Ende des ersten Drittels innen mit einem ziemlich starken spitzen Zahne, an den Vorderund Mittelfüssen Glied 3 und 4 gelappt, Hintertarsen wenig länger als die halbe Schiene, Metatarsus kaum so lang wie die folgenden Glieder zusammen; Analsegment flach, abgestutzt.

BORNEO, 1 Männchen in meiner Sammlung.

Die Art steht *A. cuneipennis* Fairm. nahe, ist aber weniger schlank, nach hinten nicht so stark verengt, hat kräftigere Fühler und stärkere Geschlechtsmerkmale an den Schienen. Bei *A. cuneipennis* sind an den Vorderfüssen Glied 1 bis 4, an den Mitteltarsen Glied 2 bis 4 gelappt.

ALLECULA DENSEPUNCTATA sp. nov.

Länge 14 bis 14.5 mm. Gestreckt, gewölbt, mässig glänzend; ziemlich dicht, mässig kurz, anliegend, gelblich behaart, Kopf und Halsschild mit spärlichen, aufrechten, längeren, dunklen Borsten; pechschwarz, Spitzen der Schienen, Füsse, Mundteile, Vorderkopf und Fühler heller oder dunkler braun. Oberlippe mässig ausgerandet, wenig gewölbt, ziemlich fein und dicht punktiert; Clypeus ziemlich quer, wenig gewölbt, dicht und ziemlich stark punktiert; Stirn leicht eingedrückt, ziemlich grob punktiert; Schläfen fast geschwunden; Halsfurche deutlich; Endglied der Kiefertaster etwa gleichschenklig dreieckig, der Lippentaster gleichschenklig beilförmig; Fühler ziemlich dünn, fast fadenförmig, länger als der halbe Körper, 3. Glied doppelt so lang wie das 1. und 2. zusammen, so lang wie das 4., folgende Glieder wenig kürzer, unter sich fast gleich, 11. fehlt; Augen sehr gross, sehr stark gewölbt, Abstand ein Viertel Durchmesser, beim Weibchen wenig mehr. Halsschild so lang wie breit, um die Hälfte breiter als der Kopf, gewölbt, schwach glockenförmig, mit ziemlich dichten, starken Augenpunkten, Mittelfurche kurz, breit, flach, Basiseindrücke sehr deutlich, Basis sehr deutlich gerandet, Winkel sehr kurz gerundet, Seiten sehr fein, herabgebogen gerandet, Apex sehr fein gerandet, etwas länger als die halbe Basis. Schildchen breit zungenförmig, mit Mittelfurche, fein, dicht punktiert. Flügeldecken ein Viertel breiter als die Halsschildbasis, von den Schultern ab schwach und allmählich

gerundet verengt bis zum letzten Viertel, dann schneller gebogen verschmälert, Punktstreifen vertieft, vorn ziemlich grob hinten viel feiner, Punkte rund und dicht; Zwischenräume leicht gewölbt, dicht, sehr fein raspelartig punktiert, Suturalstreifen ein Drittel der ganzen Länge; Schultern, Spitzen und Epipleuren normal. Unterseite vorn stark und dicht, hinten fein punktiert; Beine ziemlich, dünn, lang, Hinterschenkelspitze fast den Hinterrand des letzten Segments erreichend, Schienen wenig gebogen, Hintertarsen kürzer als die halbe Schiene, Metatarsus so lang wie die folgenden Glieder zusammen (Männchen); Lappung der Füsse: 2. bis 4., 3. und 4., 3. Glied. Das 1. Glied der Vorderfüsse ist sehr schwach erweitert.

SIBUYAN (*23581*), gesammelt von Prof. Baker, 2 Exemplare in meiner Sammlung.

Die Art ähnelt *A. cuneipennis* Fairm. und *surigaoana* sp. nov.; aber die erste ist stärker gewölbt; ihre Augen haben viel grösseren Abstand, die Fühler sind dicker, und die Behaarung ist dunkel. Die Zwischenräume sind stärker punktiert, die Beine viel länger behaart, und das Analsegment ist am Hinterrande abgestutzt. *A. surigaoana* hat hellere Beine und Fühler; die Vorderschienen des Männchen sind innen am Ende des ersten Drittels breit, flach erweitert und in den übrigen zwei Drittel flach ausgeschnitten. Die Unterseite ist lang, anliegend behaart.

ALLECULA VILLOSA sp. nov.

Länge 11.5 mm. Schlank; mässig gewölbt; ziemlich dicht, mässig lang, halb abstehend gelbbraun behaart, Unterseite feiner und anliegender; pechschwarz, Schienen, Füsse, Mundteile und Fühler (besonders gegen die Spitze) mehr rotbraun, Flügeldecken schwarzbraun. Kopf mässig dicht und ziemlich stark punktiert; Oberlippe stark querherzförmig; Clypeus quer, sehr wenig gewölbt; Stirn in der Mitte breit und flach eingedrückt; Schläfen sehr kurz; Halsfurche sehr deutlich; Endglied der Kiefertaster breit gleichschenklig dreieckig, der Lippentaster fast gleichseitig; Fühler ziemlich dünn, fadenförmig, etwa zwei Drittel der Körperlänge; gegen die Spitze dünner, 3. Glied fast doppelt so lang wie Glied 1 und 2 zusammen, so lang wie das 4., folgende Glieder sehr wenig kürzer, unter sich gleich, 11. dünn, gebogen, spitz, so lang wie das 10.; Augen stark gewölbt, Abstand halber Durchmesser. Halsschild an der Basis um die Hälfte breiter als der Kopf, so lang wie breit, leicht glockenförmig, gewölbt, mit ziemlich dichten, starken Augenpunkten, Basis scharf gerandet, mit den gewöhnlichen Eindrücken und

Ausrandungen, Seiten linienförmig, herabgebogen gerandet, allmählich verengt, Apex wenig breiter als die halbe Halsschildbasis, in der Mitte undeutlich gerandet. Schildchen zungenförmig, spärlich punktiert. Flügeldecken ein Drittel breiter als die Halsschildbasis, von den Schultern an allmählich verengt, Punktstreifen vorn grob, in der Spitze fein, vertieft, Punkte rund, tief und ziemlich dicht; Zwischenräume gewölbt, Borstenpunkte sehr fein und zerstreut; Epipleuren wenig breit, vorn sehr grob punktiert. Abdomen kräftig und ziemlich dicht punktiert, Analsegment gerade abgestutzt, in der Mitte sehr schwach breit ausgerandet; Beine lang, Schenkel sehr mässig keulig, Hinterschenkel so lang wie das Abdomen; Schienen sehr wenig gebogen; Hintertarsen kaum halb so lang wie die Schiene, Metatarsus etwas kürzer als die folgenden Glieder zusammen; Lappung der Füsse: 1.-4., 2.-4., 3. Glied.

BORNEO, Sandakan (*15820*), gesammelt von Prof. Baker, 1 Männchen in meiner Sammlung.

Die Art hat eine gewisse Verwandtschaft mit *A. cuneipennis* Fairm., ist aber kleiner und hat kräftiger und tiefer punktierten Halsschild. Die Zwischenräume der Punktstreifen sind viel spärlicher punktiert, und die Vorderschienen haben keinen stumpfen Zahn im ersten Viertel. Bei *A. cuneipennis* sind an den Vorderfüssen nur Glied 3 und 4 erweitert. *A. puerilis* Bm. von Java hat kürzeren und weitläufiger punktierten Halsschild; ihre Schenkel sind kürzer, und die Beine sind sehr lang, abstehend behaart.

ALLECULA FORTIPES sp. nov.

Länge 9 bis 9.5 mm. Wenig gestreckt, gewölbt, sehr mässig glänzend; Halsschild ziemlich dicht, halb abstehend, ziemlich kurz Flügeldecken undichter und länger braun behaart; schwarzbraun, Abdomen gegen die Spitze heller, Beine gelbbraun, Vorderkopf, Fühler und Mundteile rotbraun, Flügeldecken zuweilen gegen die Spitze heller. Kopf normal, Oberlippe und Clypeus ziemlich fein, etwas undicht, der übrige Kopf grob und mässig dicht punktiert; Oberlippe stark quer, kaum ausgerandet; Clypeus quer, wenig gewölbt; Stirn quer gewölbt, vorn flach; Schläfen sehr kurz; Halsfurche deutlich; Innenseite des Kiefertasterendgliedes etwas kürzer als die Vorderseite, Aussenseite am kürzesten, Endglied der Lippentaster kurz beilförmig; Fühler kaum halb so lang wie der Körper, mittelstark, Glieder lang und schwach dreieckig, nach aussen nicht verdickt, 3. Glied ein und ein halb mal so lang wie das 1. und 2. zusammen, 4.

kaum kürzer als das 3., 5. kürzer, 5. bis 11. unter sich gleich, 11. schräg zugespitzt; Augenabstand zwei Drittel Durchmesser. Halsschild um die Hälfte breiter als der Kopf mit den Augen, so lang wie breit oder wenig kürzer, mit groben, dichten Augenpunkten, Mittelfurche kurz und flach, Basiseindrücke flach, Basis gerandet, Seiten fein, herabgebogen gerandet, Apex in der Mitte ungerandet, etwas breiter als die Basishälfte, Seiten bis zum Anfang des letzten Drittels parallel, dann gerundet verengt. Schildchen breit zungenförmig, fein und weitläufig punktiert. Flügeldecken nicht ganz doppelt so breit wie die Halsschildbasis, von den Schultern ab wenig gerundet verengt; Punktstreifen vertieft, vorn grob, hinten feiner, Punkte rund, in der Spitze sehr fein; Zwischenräume gewölbt, mit sehr feinen, neben den Streifen fast gereihten, ziemlich dichten, in der Mitte spärlichen Borstenpunkten; Epipleuren normal, vorn sehr grob, im übrigen sehr fein raspelartig punktiert; Unterseite vorn grob und undicht, Abdomen viel feiner und dichter punktiert, Analsegment des Männchen in der Mitte sehr flach und kurz ausgerandet; Beine kräftig, Schenkel keulig, Hinterschenkelspitze fast den Hinterrand des letzten Segments erreichend, beim Weibchen viel kürzer, Schienen beim Weibchen wenig, beim Männchen Vorder- und Mittelschienen stärker gebogen, Hinterfüsse so lang wie die halbe Schiene, Metatarsus fast so lang wie die folgenden Glieder zusammen; Lappung der Füsse: 3. bis 4., 3. bis 4., 3. Glied.

MINDANAO, Lanao, Iligan (*4620*) und Bukidnon, Tangkulan (*15830*), gesammelt von Prof. Baker, 1 Männchen und 1 Weibchen in meiner Sammlung. Ein unreifes Tier von Basilan (*Baker*) in Dresden, 1 Männchen von selben Fundort, gesammelt von Böttcher, in meiner Sammlung.

Die Art ist mit *A. pallipes* Bm. verwandt, hat aber viel kürzere Fühler, dickere Beine und spärlicher punktierte Zwischenräume der Punktstreifen; ihre Augen sind weniger genähert. *Allecula suturalis* Bm. unterscheidet sich ausser durch die abweichende Färbung durch andere Bildung des Kiefertasterendgliedes und andere Lappung der Füsse.

ALLECULA AFFINIS sp. nov.

Länge 9.5 mm. Der *A. fortipes* äusserst ähnlich; pechschwarz, Flügeldecken schwarzbraun, Vorderrand der Oberlippe und des Clypeus braun; Behaarung der Schienen viel länger, innen fuchsrot, aussen lang, abstehend schwarz, Oberseite halb anliegend, mittellang, braun behaart. Kopf wie bei *A. fortipes* m.; Endglied der Kiefertaster viel breiter, nur nach innen stark erweitert, Endglied der Lippentaster ähnlich wie das Kiefer-

tasterendglied; Augenabstand halber Durchmesser; Fühler dünner, 5. Glied kaum kürzer als das 4., 11. gebogen, deutlich kürzer als das 10. Halsschild und Flügeldecken wie bei *A. fortipes.* Beine kräftig, Schenkel stark keulig, Vorder- und Mittelschienen mässig gebogen, Hinterschenkelspitze den Hinterrand des 4. Segments überragend, Hinterfüsse etwas länger als die halbe Schiene, Metatarsus so lang wie die folgenden Glieder zusammen; Analsegment nicht ausgerandet; alles übrige wie bei *A. fortipes* m.

BORNEO, Sandakan (*15814*), gesammelt von Prof. C. F. Baker, 1 Männchen in meiner Sammlung.

ALLECULA MINUTA Pic.

Länge 4.5 bis 5.5 mm. Mässig gestreckt, gewölbt, mässig glänzend; heller oder dunkler braun bis pechschwarz, Flügeldecken meistens heller, oft mit dunklerer Naht, Fühler hellbraun, jedes Glied an der Spitze dunkler, Beine viel heller, Schenkel in der zweiten Hälfte etwas, Hinterschenkel viel dunkler. Stirn und Clypeus fein und zerstreut punktiert, der übrige Kopf mit dichten, starken Augenpunkten; Oberlippe quer, vorn nicht ausgerandet; Scheitel gewölbt; Schläfen fehlen; Halsfurche undeutlich; Endglied der Kiefertaster sehr breit dreieckig, Innenseite länger als die Aussenseite; Fühler schlank, fast halb so lang wie der Körper, Glieder an der Spitze verdickt, 2. Glied so lang wie breit, 3. doppelt so lang wie das 2., 4. fast zweimal so lang wie das 3., Endglied so lang wie das 10.; Augen stark gewölbt, Abstand etwas mehr als ein halber Durchmesser, beim Männchen etwas weniger. Halsschild sehr schwach quer oder so lang wie breit, etwas flach, mit dichten, groben Nabelpunkten, allseitig fein gerandet, Seiten wenig gerundet, Basisecken fast rechtwinklig, grösste Breite vor der Mitte. Schildchen zungenförmig. Flügeldecken nicht ganz doppelt so breit wie die Halsschildbasis, von den starken Schultern ab verengt, hinter dem ersten Viertel leicht quer eingedrückt, Punktstreifen stark, Punkte grob, Zwischenräume gegen die Spitze und an den Seiten fast kielförmig, jeder mit einer Reine halbaufrechter, ziemlich langer heller Haare. Brust und Seiten des Abdomens grob punktiert; Beine mit stark keuligen Schenkeln, Vorder- und Mittelschienen ziemlich stark gebogen; Analsegment des Männchens in der Mitte mit einer glatten, dreieckigen Erhöhung, deren Spitze nach vorn zeigt; vorletztes Tarsenglied aller Füsse lappig erweitert.

LUZON, Mount Maquiling (*Baker, 4638*); BASILAN (*7276*); MINDANAO, Iligan, Dapitan, Davao, Surigao (*4246*); und PE-

NANG, 16 Exemplare in meiner Sammlung, alle von Prof. Baker gesammelt. BORNEO, Sandakan (*Baker, 15817*) und 2 Exemplare von SUMATRA, Fort de Kock (*E. Jacobson*). In meiner Sammlung sind 2 von Blaire als *A. minuta* Pic bestimmte Tiere. MINDANAO, Iligan, Butuan (*4246*); LUZON, Mount Maquiling (*4638*); und BASILAN (*7276*), 7 Tiere alle von Prof. Baker gesammelt, in Dresden.

Genus ALLECULODES Borchmann

Alleculodes BORCHMANN, Treubia 6 (1925) 335.

Die Gattung ist mit *Allecula* F. nahe verwandt. Das Endglied der Lippentaster ist nach innen viel stärker erweitert als nach aussen, mit mehr oder weniger ausgerandeter Vorderkante. Das Endglied der Kiefertaster ist aussen meist concav; die Mandibelspitze ist breit und nicht ausgerandet. Der Halsschild ist wenig gewölbt und der Länge nach mehr oder weniger deutlich breit gefurcht. Beine kurz, stark, bei den Männchen mit Geschlechtsmerkmalen. Alle Glieder der Vorderfüsse lappig erweitert. Das Übrige wie bei *Allecula*.

Bestimmungstabelle.

1 (4') Schenkel einfarbig.

2 (3) Abdomen an den Seiten auffallend stark gelb behaart; Halsschild quer, von der Basis ab schwach verengt, 4. Fühlerglied wenig länger als das 3. Länge 10 bis 13.5 mm. Pechbraun, Beine, Fühler und Flügeldecken heller; Fühler länger als der halbe Körper, Glieder an der Spitze etwas verdickt; 2., 4., 6., 8. und 9. Zwischenraum in der Spitze dicht punktiert. Singapore. *A. socia* sp. nov.

3 (2) Abdomen nicht auffällig behaart, Halsschild nicht quer, Seiten von der Basis bis zum Anfang des letzten Drittels parallel, dann gerundet verengt; 4. Fühlerglied um die Hälfte länger als das 3. Länge 15 mm. Sehr schlank; dunkelbraun, zweite Hälfte der Schienen, Füsse, Mundteile, Vorderkopf und Fühler heller, Flügeldecken schwarzbraun; 4. Fühlerglied wenig kürzer als Glied 1 bis 3 zusammen. Analsegment an der Spitze verlängert, an den Seiten stark und an der Spitze leicht ausgerandet, Vorderschienen in der Mitte zweimal erweitert und ausgerandet. Singapore. *A. analis* sp. nov.

4 (1) Schenkel mit breitem, gelbem Ringe. Länge 15 mm. Pechschwarz; die dünnen Fühler überragen die Körpermitte, 3. Glied ein Drittel kürzer als das 4.; Halsschild schwach quer, Seiten vor der Mitte leicht ausgerandet; Zwischenräume ziemlich gewölbt, wegen sehr feiner Grundskulptur seidenschimmernd, jeder mit zwei feinen, den Punktstreifen genäherten Borstenpunktreihen. Borneo. *A. genualis* Bm.

BESCHREIBUNGEN

ALLECULODES SOCIA sp. nov.

Länge 11 bis 13.5 mm. Form normal, mässig gewölbt, mässig glänzend; Kopf, Halsschild, Abdomen und Schenkel dicht, anliegend, mässig lang, Flügeldecken, Brust und Schienen länger, spärlicher, abstehender gelb behaart; pechbraun, Beine, Fühler und Flügeldecken heller. Oberlippe stark quer, wenig ausgerandet; Clypeus so lang wie breit, von der Stirn schlecht getrennt; Stirn wenig gewölbt, ziemlich grob, undicht punktiert; Schläfen gerundet, halb so lang wie ein Auge; Halsfurche breit und flach; Endglied der Kiefertaster normal; Fühler fast fadenförmig, die Körpermitte überragend, jedes Glied gegen die Spitze etwas verdickt, leicht gebogen (Glied 10 und 11 fehlen), 3. Glied um die Hälfte länger als das 1. und 2. zusammen, deutlich kürzer als das 4., folgende Glieder unter sich gleich; Augenabstand halber Durchmesser. Halsschild leicht quer, wenig gewölbt, doppelt so breit wie der Kopf, ziemlich dicht, mässig fein und flach punktiert, Mittelfurche nur an der Basis, Basiseindrücke kräftig, Seiten schwach und allmählich, vom letzten Drittel an stärker gerundet verengt, nahe der Basis sehr leicht ausgeschweift, gerandet, Rand in der letzten Hälfte von oben sichtbar, Apex in der Mitte ungerandet. Schildchen zungenförmig, dicht behaart. Flügeldecken normal; Punktstreifen vertieft, vorn grob, hinten fein punktiert; Zwischenräume gewölbt, vorn mit je einer Reihe feiner Borstenpunkte neben den Punktstreifen, 2., 4., 6., 8. und 9. hinten dicht punktiert; Schultern, Spitzen und Epipleuren normal. Abdomen fein und sehr dicht punktiert; Beine kräftig, Schenkel keulig, Hinterschenkelspitze den Hinterrand des 4. Segments fast erreichend; Vorderschienen kräftig gekrümmt, innen in der Mitte etwas verbreitert, Mittel- und Hinterschienen fast gerade; Metatarsus der Hinterfüsse etwas länger als die zwei folgenden Glieder zusammen; Analsegment kurz abgestutzt und in der zweiten Hälfte flach; Lappung der Füsse: 2.-4., 3.-4., 3. Glied.

SINGAPORE, gesammelt von Prof. Baker, 2 Weibchen in meiner Sammlung.

Die Art unterscheidet sich von *A. latipes* Bm. durch die viel dichtere Behaarung und die Punktierung der geraden Zwischenräume auf den Flügeldecken. *Alleculodes latipes* hat eine vollständige Mittelfurche auf dem Halsschilde, und die Lamellen der Füsse sind viel breiter.

ALLECULODES ANALIS sp. nov.

Länge 15 mm. Sehr schlank, mässig gewölbt, ziemlich glänzend; ziemlich lang, mässig dicht, halb anliegend gelblich behaart, Unterseite viel feiner, kurz, anliegend behaart, Schienen dicht, halb abstehend, halblang beborstet; dunkel pechbraun, zweite Hälfte der Schienen, Füsse, Mundteile, Vorderkopf und Fühler heller, Fühlerglieder mit dunklerer Spitze, Flügeldecken schwarzbraun. Oberlippe mindestens dreimal so breit wie lang, seicht breit ausgerandet; Clypeus wenig gewölbt, etwas quer, mittelstark, ziemlich dicht punktiert, von der Stirn durch einen breiten, undeutlichen Quereindruck getrennt; Stirn vorn flach, sehr grob, undicht punktiert; Schläfen sehr kurz; Halsfurche breit, in der Mitte undeutlich; Endglied der Kiefertaster vorn und aussen gleich lang, Innenkante halb so lang wie die Vorderkante; Fühler schlank, fast fadenförmig, gegen die Spitze dünner, 3. Glied um die Hälfte länger als 1. und 2. zusammen, etwas gebogen und gegen die Spitze verdickt, 4. wenig kürzer als Glied 1 bis 3 zusammen, folgende Glieder unter sich gleich, 11. am dünnsten, leicht gebogen; Augen gross, Abstand etwa ein Viertel Durchmesser. Halsschild doppelt so breit wie der Kopf, so lang wie breit gewölbt, mit breiter, flacher, vollständiger Mittelfurche, ziemlich grob, nicht sehr dicht, wenig tief punktiert, Basiseindrücke flach und klein, Basis kräftig gerandet, Seiten bis über die Mitte gerade und parallel, dann schnell gerundet verengt, fein und sehr wenig herabgebogen gerandet, sodass der Rand von oben teilweise sichtbar ist, Apex kräftig gerandet. Schildchen halb sechseckig, mit Mittelfurche, fein punktiert. Flügeldecken ein Viertel breiter als die Halsschildbasis, von den Schultern an gleichmässig gerundet verengt; Punktstreifen kräftig, in der Spitze sehr fein; Zwischenräume gewölbt, sehr spärlich mit feinen und groben Borstenpunkten besetzt; Spitzen kurz einzeln gerundet; Epipleuren vorn ziemlich breit, schnell verengt, vorn mit zwei sehr groben Punktreihen neben dem Innenrande, der übrige Teil fein, undicht, etwas querrunzelig punktiert; Analsegment an der Seite vor der Spitze stark ausgerandet, an der Spitze schwach ausgerandet, abgestutzt, 3. und 4. Segment in der Mitte breit rechteckig ausgerandet, mit bogenförmig vorgezogener heller Gelenkhaut; Beine kräftig, Schenkel ziemlich stark keulig, Schienen gebogen, Hinterschienen doppelt, Hinterschenkelspitzen erreichen kaum den Hinterrand des 4. Segments, Vorderschenkel hinten schwach und breit ausgeschnitten, Innenkante gezähnt, Vorderschienen etwas flach,

in der Mitte zweimal erweitert und dann ausgerandet, Hinterfüsse länger als die halbe Schiene, Metatarsus so lang wie die zwei folgenden Glieder zusammen; Lappung der Füsse: 1.-4., 1.+4., 3. Glied.

SINGAPORE (*23580*), gesammelt von Prof. Baker, 1 Männchen in meiner Sammlung.

Die Art ist am nächsten mit *A. varus* Bm. verwandt. Diese ist aber viel heller gefärbt, ihr 4. Fühlerglied ist kürzer, die Vorderfüsse sind stärker gedreht, und die Auszeichnung des Analsegments ist ganz anders.

ALLECULODES GENUALIS Bm.

Alleculodes genualis BORCHMANN, Treubia 6 (1925) 336, 340.

Bisher war nur das Weibchen bekannt. In meiner Sammlung findet sich ein Männchen, das hier beschrieben werden soll. Schlanker, Flügeldecken von der Schulter bis etwas hinter der Mitte sehr schwach, fast gerade, dann stärker gerundet verengt, stärker gewölbt; Abstand der Augen kaum ein Viertel Durchmesser; Fühler mehr als drei Viertel der Körperlänge (Glied 10 und 11 fehlen), fadenförmig, ziemlich dünn, 4. Glied um die Hälfte länger als das 3., folgende Glieder wenig kürzer, unter sich gleich, alle schwach gebogen und an der Spitze leicht verdickt. Halsschild so lang wie breit, Apex in der Mitte ungerandet. Schildchen mit Mittelfurche. Beine mit stark keuligen Schenkeln, Vorderschenkel unten der ganzen Länge nach ausgeschnitten, Hinterschenkel gebogen, den Hinterrand des 4. Segments überragend, Vorderschienen doppelt gebogen, eben vor der Mitte mit einem starken und sehr breiten Zahne, 2. Hälfte der Schienen breit ausgerandet, Mittelschienen mässig gebogen, Hinterschienen fast so lang wie der Schenkel, doppelt gebogen, bis zur Mitte allmählich verbreitert und dann bogig ausgeschnitten verengt; Hinterfüsse so lang wie die halbe Schiene, Metatarsus etwas länger als die zwei folgenden Glieder zusammen; Analsegment an der Spitze stark gerundet, mit grosser, flacher, breiter Grube; Lappung der Füsse: 1.-4., 1.-4., 3. Glied.

Ein Männchen von Borneo: Sandakan (Nr. 10134), gesammelt von Prof. Baker, in meiner Sammlung.

Genus OMMATOCHARA novum

Die neue Gattung enthält Tiere von der äusseren Erscheinung von *Borboresthes*-Arten. Kopf kurz, Mundteile wie bei *Borboresthes* Fairm. Fühler fadenförmig. Die grossen, stark

ausgerandeten Augen treten seitlich stark eckig vor. Sie sind oben gut und unten sehr weit getrennt. Der Halsschild ist querviereckig mit breit abgerundeten Vorderecken, allseitig gerandet, Apex wenig nach vorn gerundet, Fläche im vorderen Drittel ziemlich stark gewölbt, gegen die Basis fast flach, dicht mit Augenpunkten besetzt, Basis wie bei *Borboresthes*. Schildchen querdreieckig. Flügeldecken am Grunde wenig breiter als der Halsschild, nach hinten wenig erweitert, mit kräftigen, vertieften Punkstreifen; Zwischenräume gewölbt. Alles Übrige wie bei der vergleichenen Gattung. Von *Cistelopsis* Fairm. unterscheidet sich die Gattung durch die Halsschildform, die vorstehenden Augen und die anders skulptierten Zwischenräume der Punktstreifen. Mir sind nur Vertreter von den Philippinen bekannt geworden. Die Type der Gattung ist *O. tibialis* m.

Bestimmungstabelle.

1 (14) Die Männchen ohne Geschlechtsmerkmale an den Beinen.

2 (11) Käfer grösser, weniger gewölbt, nicht sehr gestreckt.

3 (10) Halsschild gegen die Mitte nicht merklich erweitert.

4 (7) Zwischenräume ziemlich dicht punktiert, leicht querrunzelig.

5 (6) Schienen und Füsse gelb. Länge 6.5 bis 7.5 mm. Rotbraun, Mitte der Unterseite dunkler, Oberseite schwarzbraun; Fühler und Taster hellbraun. Es gibt auch Tiere mit ganz hellgelben Beinen. Fühler kräftig, 3. und 4. Glied gleich. Halsschild grob und sehr dicht punktiert. Sibuyan und Negros.
O. tibialis sp. nov.

6 (5) Schienen und Füsse mit den Schenkeln gleichfarbig braun. Länge 6.5 mm. Dunkel rotbraun, Beine und Seiten des Abdomens wenig heller, Fühler einfarbig hell; mässig lang hell behaart. Fühler ziemlich dünn, 3. und 4. Glied gleich. Halsschild mit sehr dichten, ziemlich starken Augenpunkten, weniger gewölbt. Palawan .... *O. palawana* sp. nov.

7 (4) Zwischenräume nicht querrunzelig.

8 (9) Punkte der Zwischenräume so gross wie die Punkte in den Streifen, Punkte länglich; Gestalt normal. Länge 4 mm. Dunkelbraun bis pechbraun, Beine, Taster und Fühler rotbraun, Flügeldecken meist etwas heller als der Vorderkörper. Fühler kräftig, etwas flach. Halsschild stark und dicht punktiert, Basisecken nach hinten etwas vorgezogen. Borneo........ *O. sericea* sp. nov.

9 (8) Punkte der Zwischenräume viel feiner als die Punkte in den Streifen, rund; Gestalt gestreckter. Länge 5.25 mm. Ziemlich dunkel rotbraun, Beine und Fühler heller, Flügeldeckennaht sehr schmal, schwarz. Fühler mässig stark. Halsschild dicht und mittelfein punktiert, fast halbkreisförmig, Basiswinkel nach hinten leicht vorgezogen. Punktstreifen ziemlich fein, kaum vertieft. Zwischenräume fast flach, zweireihig punktiert. Luzon .... *O. suturalis* sp. nov.

10 (3) Halsschild schwach, aber deutlich gegen die Mitte erweitert. Länge 5 mm. Schwarzbraun, Beine viel, Fühler wenig heller, Schultern etwas rötlich; ziemlich lang, anliegend, weisslich behaart; Augen sehr stark vorstehend; Fühler etwas länger als der halbe Körper, etwas gesägt. Halsschild sehr grob punktiert. Zwischenräume der Fügeldecken ziemlich grob und runzelig punktiert. Sibuyan .... *O. bakeri* sp. nov.

11 (2) Käfer sehr klein, sehr wenig gestreckt, stärker gewölbt.

12 (13) Oberseite ganz dunkel, Flügeldecken in der Spitze am stärksten gewölbt, nach hinten wenig verengt. Länge 2.7 bis 3 mm. Fast oval; pechbraun, Beine wenig heller, Kopf und erste Drittel der Fühler rotbraun. Fühler kräftig, fast halb so lang wie der Körper, sehr schwach gesägt. Halsschild dicht und grob punktiert. Jeder Zwischenraum mit zwei fast regelmässigen Borstenpunktreihen. Basilan, Mindanao, und Palawan.
O. minutissima sp. nov.

13 (12) Halsschild rot; Käfer nach hinten viel mehr verengt und weniger gewölbt; rotbraun, Beine braun, Füsse viel heller, Fühlerbasis braun, Flügeldecken schwarz; ziemlich lang, anliegend weisslich behaart. Basilan, Mindanao, und Palawan. Vielleicht nur Abart der vorigen! .... *O. ruficollis* sp. nov.

14 (1) Männchen an den Beinen mit starken Geschlechtsmerkmalen, die jedoch bei schwachen Stücken undeutlich sein können. Länge 5.5 mm. Rotbraun, Halsschild und ein dreieckiger Fleck in der ersten Hälfte der Flügeldecken am Rande unbestimmt begrenzt, schwarz, Fühler, Füsse und der Hinterleib gegen die Spitze heller; undicht, halblang, anliegend gelbbraun behaart. Fühler etwas kürzer als der halbe Körper. Vorderschienen gebogen, in der ersten Hälfte innen breit und ziemlich tief ausgeschnitten, Hinterschenkel breit, Hinterseite erweitert, scharf gerandet, Hinterschienen in der Mitte breit erweitert. Mindanao.
O. postfemoralis sp. nov.

NEUE ARTEN

OMMATOCHARA TIBIALIS sp. nov.

Länge 6.5 bis 7.5 mm. Länglich, mässig gewölbt, mässig glänzend; fein kurz, mässig dicht, anliegend hell behaart; rotbraun, Mitte der Unterseite dunkler, Oberseite schwarzbraun, Schienen und Füsse gelb, Fühler und Taster hellbraun, bei einem Tier sind die ganzen Beine gelb. Kopf dicht und mässig stark punktiert; Oberlippe stark quer, sehr schwach ausgerandet, sehr fein punktiert; Clypeus gewölbt, quer, von der Stirn durch eine breite, in der Mitte gerade Furche abgesetzt; Stirn wenig gewölbt; Halsfurche undeutlich; Augenabstand etwa halber Durchmesser; Schläfen sehr kurz, senkrecht; Fühler kräftig, fadenförmig, halb so lang wie der Körper, 3. und 4. Glied gleich, folgende Glieder wenig kürzer, 10. und 11. gleich. Halsschild zwei

Drittel so lang wie die Basis, mit groben, dichten Augenpunkten, die sehr schmalen Zwischenräume bilden stellenweise Runseln, Basis mit drei sehr seichten, breiten Gruben, Basiswinkel rechteckig. Schildchen sehr dicht punktiert. Flügeldecken etwa viermal so lang wie der Halsschild, Punktstreifen tief eingedrückt, Zwischenräume besonders gegen die Spitze ziemlich stark gewölbt, ziemlich dicht, fein, querrunzelig punktiert; die vorn breiten Epipleuren endigen nahe der Spitze, Schultern mässig stark, Spitzen sehr kurz einzeln gerundet. Unterseite glänzender, Brust ziemlich grob, mässig dicht, Hinterleib feiner, zerstreuter punktiert, Seiten mit feiner Grundskulptur, 1. bis 3. Segment etwas längsrissig, 4. und 5. enfach fein und zerstreut punktiert; Beine sehr kräftig, Schenkel keulig, fein und anliegend, Schienen gerade und etwas länger behaart; Analsegment gerundet; Hintertarsen kaum halb so lang wie die Schiene, Metatarsus deutlich länger als die folgenden Glieder zusammen, 2. bis 4. Glied der Vordertarsen, 3. und 4. der Mitteltarsen und vorletztes der Hintertarsen lappig erweitert.

SIBUYAN, 1 Tier, und NEGROS, Cuernos Mountains, 2 Tiere (*Baker*), in meiner Sammlung.

OMMATOCHARA PALAWANA sp. nov.

Länge 6.5 mm. Form wie *O. tibialis* m., mässig glänzend, halb abstehend, mässig lang, ziemlich dicht hell behaart; dunkel rotbraun, Beine und Seiten des Abdomens wenig heller, Fühler hell, einfarbig. Kopf sehr dicht punktiert; Oberlippe stark quer, sehr schwach ausgerandet; Augenabstand drei Viertel Durchmesser; Fühler kürzer als der halbe Körper, ziemlich dünn, 3. und 4. Glied gleich, folgende Glieder wenig kürzer; Stirn kaum gewölbt; Halsfurche nicht erkennbar. Halsschild halb so lang wie breit, mässig gewölbt, sehr dicht mit ziemlich starken Augenpunkten besetzt, Zwischenräume schmal, etwas längsstreifig, Seiten an der Basis äusserst schwach ausgeschweift, alles Übrige wie bei *tibialis*. Schildchen normal. Flügeldecken nach hinten sehr schwach erweitert, ziemlich stark gewölbt, Punktstreifen kräftig und vertieft, Zwischenräume ziemlich gewölbt, mit dichten, raspelartigen Punkten, die viel feiner sind als die Punkte in den Streifen; Schultern, Apex und Epipleuren normal. Unterseite glänzender, Punktierung gewöhnlich, Analsegment in der Mitte gerundet, daneben jederseits leicht und kurz ausgerandet; Beine gewöhnlich; Hintertarsen etwas länger als die halbe Schiene; Metatarsus der Hinterfüsse so lang wie die folgenden Glieder zusammen.

PALAWAN, Puerto Princesa (*Baker*), 1 Weibchen im Museum in Dresden.

Die Art ist der *O. tibialis* m. sehr ähnlich, unterscheidet sich aber durch die dunklen Schienen, den weniger gewölbten Halsschild, die kräftigeren und kürzeren Fühler, die weniger vorstehenden Augen und die längere Behaarung der Flügeldecken.

OMMATOCHARA SERICEA sp. nov.

Länge 4 mm. Form gewöhnlich, mässig gewölbt, ziemlich glänzend; Behaarung normal; dunkelbraun bis pechbraun, Beine, Taster und Fühler rotbraun, Flügeldecken etwas heller als der Vorderkörper. Kopf sehr kurz, dicht und stark punktiert; Oberlippe sehr kurz; Clypeus stark quer; Stirn gewölbt; Augen stark genähert, Abstand etwa ein Viertel Durchmesser (beim Weibchen Augen schmäler), Abstand etwas grösser; Fühler kräftig, etwas flach, die Körpermitte lange nicht erreichend, 3. und 4. Glied gleich. Halsschild stark und dicht punktiert, halb so lang wie die Basis, Basisecken nach hinten schwach vorgezogen, Eindrücke sehr flach; Flügeldecken nach hinten leicht verengt, grösste Breite nahe der Basis, Punktstreifen kräftig, sehr wenig vertieft, Zwischenräume flach, die reihigen Punkte eben so gross wie die Punkte in den Streifen; Epipleuren dicht und ziemlich grob punktiert. Unterseite normal, Hinterleib ziemlich dicht und stark punktiert; Beine kurz, Schenkel keulig; Hinterschenkelspitze den Hinterrand des zweiten Segments wenig überragend, beim Weibchen länger; Hintertarsen zwei Drittel der Schiene, Metatarsus etwas länger als die folgenden Glieder zusammen.

BORNEO, Sandakan (*Baker, 15838*), 3 Exemplare in meiner Sammlung, 1 im Museum in Dresden.

Die Art ist der *O. bakeri* m. verwandt; aber ihr Halsschild erweitert sich nicht nach vorn, und die Zwischenräume der Flügeldecken sind flach und viel weniger stark punktiert.

OMMATOCHARA SUTURALIS sp. nov.

Länge 5.25 mm. Etwas schlanker als gewöhnlich, mässig gewölbt, mässig glänzend, mässig kurz, anliegend, hell behaart, ziemlich dunkel rotbraun, Beine und Fühler heller, Flügeldeckennaht sehr schmal schwarz. Kopf sehr dicht und mässig stark punktiert; Clypeus und Oberlippe normal; Augen stark gewölbt, Abstand halber Durchmesser; Fühler mässig stark (unvollständig), 3. und 4. Glied gleich. Halsschild mässig gewölbt, fast halbkreisförmig, sehr dicht und mittelfein punktiert, grösste Breite an der Basis, Basiswinkel nach hinten leicht vorgezogen.

Schildchen breit, Halb sechseckig. Flügeldecken mässig gewölbt, nach hinten kaum erweitert, ziemlich glänzend; Punktstreifen ziemlich fein, kaum vertieft, Punkte länglich; Zwischenräume auch in der Spitze fast flach, mit zweireihigen, ziemlich feinen, flachen, runden Punkten besetzt, die deutlich feiner sind als die Punkte in den Streifen; Spitzen zusammen abgerundet, Schultern normal, Epipleuren nicht ausgehöhlt. Unterseite und Beine normal; Hintertarsen zwei Drittel der Schiene; Metatarsus der Hinterfüsse länger als die folgenden Glieder zusammen.

LUZON, Mount Banahao, 1924, 2 Exemplare im Museum in Dresden.

Die Art unterscheidet sich von *O. sericea* m. durch ihre gestrecktere Gestalt, die geringere Wölbung, die viel feineren Punkstreifen und die fast flachen Zwischenräume. *Ommatochara postfemoralis* hat viel kürzeren Halsschild, dünnere Fühler, gewölbtere Zwischenräume und abweichende Beinbildung.

OMMATOCHARA BAKERI sp. nov.

Länge 5 mm. Schwarzbraun, Beine viel, Fühler wenig heller, Schultern etwas rötlich; mässig glänzend; ziemlich lang, mässig dicht, anliegend weisslich behaart. Augen schmal, sehr stark abstehend, Abstand halber Durchmesser; Fühler kräftig, etwas länger als der halbe körper, etwas gesägt, 3. und 4. Glied gleich. Halsschild vorn stark gewölbt, etwas länger als die halbe Basis, mit sehr dichten, groben Augenpunkten, Basis neben den Ecken noch einmal leicht gebuchtet, Grübchen deutlich, Seiten bis gegen die Mitte schwach erweitert, Basisecken etwas stumpfwinklig. Flügeldecken mit mässig starken Punktstreifen, die gegen die Spitze tiefer werden; Zwischenräume mässig gewölbt, mit undichten, ziemlich groben Punkten besetzt, die ziemlich starke Querrunzeln bilden; Spitzen äusserst kurz einzeln gerundet, Epipleuren skulptiert wie die Zwischenräume. Unterseite wie bei *tibialis;* Vorderschenkel gebogen, Vorderschienen gekrümmt; Hintertarsen drei Viertel so lang wie die Schiene, Metatarsus bedeutend länger als die folgenden Glieder zusammen.

SIBUYAN (*Baker*), 2 Tiere in meiner Sammlung.

Die Art unterscheidet sich leicht durch den nach vorn erweiterten Halsschild, die stärkere Punktierung und die längere Behaarung.

Ein Tier von Negros, Cuernos Mountains, ist dunkler; die zwei Schenkelhälfte, die Schienen und Füsse sind rotbraun. Das Analsegment ist gerundet und vor der Spitze flach quer einge-

drückt; die Mittel- und Hinterbrust sind stärker punktiert. Es scheint ein Weibchen zu sein.

OMMATOCHARA MINUTISSIMA sp. nov.

Länge 2.75 bis 3 mm. Fast oval, Käfer nach hinten wenig mehr als nach vorn verengt, ziemlich gewölbt, mässig glänzend; Oberseite ziemlich lang, mässig dicht, fast anliegend hell behaart, Haare des Halsschildes nach hinten gelagert; pechbraun, Beine wenig heller, Kopf und erste Drittel der Fühler, zuweilen auch der Halsschild rotbraun. Kopf kurz, ziemlich grob und dicht punktiert; Oberlippe stark quer, Vorderecken abgerundet, kaum erkennbar ausgerandet; Clypeus doppelt so breit wie lang, wenig verengt, von der Stirn breit und flach abgesetzt; Stirn gewölbt; Schläfen halb so lang wie ein Auge, plötzlich stark verengt, sodass die Augen, von hinten gesehen, auf einer Erhöhung stehen; Hals oben sehr wenig abgeschnürt; Mundteile gewöhnlich; Fühler fast halb so lang wie der Körper, kräftig, sehr schwach gesägt, 2. Glied ein Drittel kürzer als das 1., dieses kaum doppelt so lang wie breit, 3. so lang wie das 1. und 2. zusammen, so lang wie das 4., dieses und die folgenden Glieder dicker, an länge kaum verschieden, 11. schwach gebogen, zugespitzt, etwas dünner, so lang wie das 10.; Augen schmal, stark, etwas eckig vorstehend, deutlich ausgerandet, stark nach vorn stehend. Halsschild doppelt so breit wie lang, über doppelt so breit wie der Kopf mit den Augen, besonders vorn gewölbt, sehr dicht mit groben Augenpunkten besetzt, Basis mit den normalen Eindrücken und Ausbuchtungen, fein gerandet, Seiten und Apex fein gerandet, Seiten in der ersten Hälfte fast gerade, parallel, dann gerundet verengt, Vorderecken verrundet, Basisecken rechtwinklig. Schildchen breit, dicht und ziemlich stark punktiert. Flügeldecken so breit wie die Halsschildbasis, ziemlich stark gewölbt, glänzend, Punktstreifen stark, in der Spitze wenig schwächer, Punkte rund und ziemlich dicht; Zwischenräume ziemlich gewölbt, jeder mit zwei fast regelmässigen Borstenpunktreihen, Borstenpunkte fein; Schultern etwas eckig; Epipleuren vorn ziemlich breit, am Innenrande mit einer Reihe sehr grober Punkte, allmählich verengt, kurz vor der Spitze endend; Spitzen zusammen gerundet. Unterseite vorn grob und dicht, hinten viel feiner punktiert. Beine mittelstark, Schenkel keulig, Schienen fast gerade, Hinterschenkelspitze den Hinterrand des 3. Segments erreichend, nur das vorletzte Tarsenglied aller Füsse deutlich gelappt; Metatarsus der Hinter-

füsse mindestens so lang wie die drei folgenden Glieder zusammen.

BASILAN (*Baker, 24052*) 3 Exemplare in meiner Sammlung.

OMMATOCHARA RUFICOLLIS sp. nov.

Länge 3 mm. Nach hinten deutlich verengt und viel weniger gewölbt als *minutissima;* Unterseite (besonders der Vorderkörper), Kopf, Halsschild und Fühlerbasis rotbraun, Beine pechbraun, Füsse heller. Flügeldecken schwarz; ziemlich lang, anliegend, mässig dicht, weisslich behaart. Kopf wie bei *minutissima* m., grob punktiert; Fühler dick, nicht ganz halb so lang wie der Körper, 3. und 4. Glied gleich; Augenabstand etwas weniger als ein Durchmesser. Halsschild drei Viertel so lang wie die Basishälfte, grob und sehr dicht punktiert, Basisecken nach hinten leicht vorstehend. Flügeldecken so breit wie die Halsschildbasis, Punktstreifen vertieft, ziemlich stark punktiert, Zwischenräume nur an den Seiten und in der Spitze etwas stärker gewölbt, fein raspelartig, etwas reihig punktiert, 1. Streifen an der Spitze ziemlich tief eingedrückt; Spitzen zusammen gerundet. Unterseite vorn ziemlich grob, hinten wenig feiner punktiert, Abdomen etwas längsrissig; Beine mit keuligen Schenkeln, Hinterfüsse zwei Drittel so lang wie die Schiene, Metatarsus etwas länger als die folgenden Glieder zusammen.

BASILAN (*Baker*), 1 Exemplar in meiner Sammlung, 1 von Mindanao, Iligan (*Baker*) im United States National Museum; 4 von Palawan, Binaluan, im Dresdener Museum.

Die Art ist mit *O. minutissima* m. verwandt, unterscheidet sich aber leicht durch die abweichende Form und Färbung.

OMMATOCHARA POSTFEMORALIS sp. nov.

Länge 5.5 mm. Rotbraun, Halsschild und vordere Hälfte der Flügeldecken (mit unbestimmter Grenze) dunkler, Fühler, Füsse und der Hinterleib gegen die Spitze heller; Oberseite undicht, halb abstehend, mässig lang, gelbbraun behaart. Kopf ziemlich stark und dicht punktiert; Oberlippe weniger, Clypeus stark quer. Stirn sehr kurz, Augen vorn fast zusammenstossend; Halsfurche etwas deutlicher; Fühler die Körpermitte nicht ganz erreichend, ziemlich kräftig, 3. und 4. Glied gleich; Halsschild stark quer, kaum halb so lang wie die Basis, weniger dicht mit groben Augenpunkten besetzt, Punkte wenig tief, Basis neben den Ecken noch einmal schwach gebuchtet, Grübchen etwas tiefer als bei *tibialis*, Punkstreifen weniger tief, Zwischenräume weniger gewölbt, jeder mit ein oder zwei Reihen Borstenpunkten, die fast so gross sind wie die Punkte in den

Streifen, Spitzen breiter einzeln gerundet, Epipleuren weniger verengt; Unterseite glänzend; Vorderkörper (auch an den Seiten des Halsschildes) grob und dicht punktiert, Abdomen wie bei *tibialis;* Analsegment flach, Spitze gerundet; Beine kräftiger, Vorderschienen gebogen, innen in der ersten Hälfte breit und ziemlich tief ausgeschnitten, Mittelschienen gegen die Spitze verbreitert, Hinterschenkel breit, Hinterseite erweitert, scharf gerandet, Hinterschienen in der Mitte hinten breit erweitert, Hintertarsen fast so lang wie die Schiene, Metatarsus viel länger als die folgenden Glieder zusammen.

MINDANAO, Butuan (*Baker*), 1 Männchen und 1 Weibchen in meiner Sammlung. MINDANAO, Butuan und Iligan, 5 Exemplare im Museum in Dresden. Die Tiere sind schwächer; die Männchen haben undeutliche geschlechtsmerkmale.

Die Art ist der *O. tibialis* m. sehr ähnlich, unterscheidet sich aber sehr leicht durch die eigenartige Bildung an den Hinterbeinen.

Genus PALPICHARA novum

Die neue Gattung ist nahe verwandt mit *Allecula* F. Stark gestreckt; Kopf kurz, Augen sehr gross, vorn (wenigstens beim Männchen) in einer Linie sich berührend, Abstand auf der Unterseite gering; Fühler schlank, kaum halb so lang wie der Körper, vom 4. Gliede an schwach gesägt, 4. Glied doppelt so lang wie das 3., folgende wenig kürzer, gegen die Spitze dünner und stärker gesägt, Endglied dünn und spitz. Linkes Kiefertasterendglied sehr breit und quer, innerer Zipfel umgeschlagen, rechtes etwas schmäler, innerer Zipfel abwärts gebogen, Endglied der Lippentaster beilförmig. Halsschild schwach gewölbt, etwas länger als die halbe Basis, Seiten bis zur Mitte scharf gerandet, dann stumpfkantig, gerundet verengt und linienförmig gerandet, Vorderecken gänzlich verrundet. Flügeldecken schmal, Punktstreifen kräftig; Zwischenräume mit fast zweireihigen Punkten von der Grösse der Punkte in den Streifen. Alles Übrige wie bei *Allecula. Palpichara* weicht ab durch die eigentümliche Tasterbildung, die gesägten Fühler, den flachen Halsschild und die grob punktierten Zwischenräume. Bisher ist nur die eine von mir beschriebene neue Art bekannt. Die Type ist *P. serricornis* m.

PALPICHARA SERRICORNIS sp. nov.

Länge 9 bis 9.5 mm. Schmal, mässig glänzend, ziemlich lang, mässig dicht, etwas abstehend, gelblich behaart; rotbraun,

Brust, Kopf und Halsschild dunkler, Beine heller; Mundteile und Fühler hell. Kopf kurz, stark und ziemlich dicht punktiert; Oberlippe stark quer, stark ausgerandet, flach; Clypeus mit breiter Gelenkhaut, stark quer, vorn gerade, durch eine scharfe, doppelt gebogene Linie abgesetzt; Schläfen sehr kurz; Hals ziemlich schmal, stark abgeschnürt; Endglied der Kiefertaster nach innen wenig erweitert, der Lippentaster fast beilförmig, vorn etwas schräge; Fühler nicht ganz die Körpermitte erreichend, nach aussen dünner, vom 4. Gliede an deutlich gesägt, alle Glieder mit Ausnahme des 2. deutlich gestreckt, 1. Glied dick, etwa doppelt so lang wie an der Spitze breit, 2. ein Drittel so lang, 3. wenig kürzer als das 1., 4. länger als das 2. und 3. zusammen, folgende Glieder nicht verkürzt, 11. dünn, etwas spitz, gebogen, so lang wie dass 10.; Augen sehr gross, vorn zusammenstossend, stark ausgerandet, unten fast aneinander stehend. Halsschild nicht deutlich breiter als der Kopf, wenig gewölbt, mit groben, dichten Augenpunkten, etwas breiter als lang, Basis stark doppelbuchtig, vor jeder Ausbuchtung eine breite Grube, vorgezogene Mitte flach, Basisecken fast rechtwinklig, Seiten vom Anfang des 2. Drittels an stark gerundet verengt, Vorderecken verrundet, alle Seiten fein gerandet. Schildchen zungenförmig, dicht und stark punktiert. Flügeldecken etwas breiter als die Halsschildbasis, mit kräftigen Schultern, mässig gewölbt, fast von der Schulter ab nach hinten allmählich verengt, Spitzen einzeln kurz gerundet; Punktstreifen wenig vertieft, Punkte sehr dicht, in der Spitze feiner, Zwischenräume wenig gewölbt, jeder zweireihig und stärker punktiert als die Streifen; Epipleuren schmal, vertieft, nur am Aussenrande mit einer Punktreihe. Unterseite ziemlich stark, wenig dicht punktiert und anliegend behaart; Prosternalfortsatz normal; Abdomen spärlicher und gegen die Spitze fein und zerstreut punktiert, Analsegment an der Spitze einfach gerundet; Beine kräftig, mit ziemlich dicken Schenkeln, die Spitze der Hinterschenkel überragt den Hinterrand des 3. Segments nur wenig, Schienen gerade, an den beiden ersten Fusspaaren Glied 2 bis 4, an den Hinterfüssen Glied 2 und 3 lappenartig erweitert, das 1. Glied der Vorder- und Mitteltarsen sehr kurz verlängert, Metatarsus der Hinterfüsse länger als die folgenden Glieder zusammen.

SINGAPORE, gesammelt von Prof. Baker, 2 Männchen in meiner Sammlung. Dem einen Tiere fehlen die Taster, bei dem andern scheinen die Endglieder der Kiefertaster monströs zu

sein; das linke ist ausserordentlich stark nach innen verlängert und zusammengerollt, das rechte nach innen fast gar nicht erweitert.

Genus CISTELOMORPHA Redtenbacher

Cistelomorpha Redtenbacher, Reise Novara 2 (1857–1859) 134; Seidlitz, Nat. Ins. Deutschl. 5 (1896) 173 nota; Pic, Échange 24 (1908) 38–40, 47–48, 56, 61–62 (Tabelle).

Der guten Beschreibung Redtenbachers ist nicht viel hinzuzufügen. Oberseite fast immer fein, kurz, anliegend, ziemlich dicht gelblich behaart; Kopf meist stark gestreckt, Oberlippe meist schwach querherzförmig, Clypeus meistens wenig länger als breit, nach vorn wenig verengt, vorn gerade, von der Stirn durch eine gebogene, mehr oder weniger tiefe und breite Furche getrennt; Stirn gewölbt; Hals meist breit, wenig tief abgeschnürt; Mandibeln einspitzig, Endglied der Kiefertaster bedeutend länger als das vorhergehende, vorn schräge abgestutzt, Endglied der Lippentaster mehr oder weniger beilförmig; Augen stark gewölbt, ausgerandet, Abstand auf der Stirn mindestens einen Durchmesser; Fühler vom 4. Gliede an schwach gesägt, erreichen meist nicht ganz die Körpermitte; das 3. Glied ist fast immer das längste. Der Halsschild ist gewölbt, meistens wenig länger als die halbe Basis, oft fast halbkreisförmig, allseitig gerandet, Vorderecken ganz oder fast ganz verrundet, Basiswinkel mehr oder weniger kurz gerundet rechteckig; die Basis ist jederseits schwach ausgerandet auf der Fläche in der Mitte und vor jeder Ausrandung ein Grübchen. Schildchen mehr oder weniger spitz dreieckig. Die Flügeldecken sind etwas breiter als die Halsschildbasis, meist ziemlich stark gewölbt, mit kräftigen Punktstreifen, die in seltenen Fällen in der zweiten Hälfte gestört sind, entweder ganz aufgelöst, oder nach aussen gebogen, sich in verschiedener Weise vereinigen, Zwischenräume der Punktstreifen meistens fein und ziemlich dicht punktiert, mehr oder weniger gewölbt, oft von verschiedener Breite und Höhe (ungerade breiter und gewölbter), Schultern etwas buckelig, mit erloschenen Punktstreifen, Epipleuren endigen eben vor der Spitze, Flügeldeckenspitzen fast immer kurz einzeln gerundet. Unterseite dicht behaart und dicht und fein punktiert; Prosternalfortsatz fast immer wenig höher als die Hüften, mit schmaler Fläche; Beine kräftig, dicht punktiert und behaart, Oberschenkel wenig platt, Schienen wenig gebogen, gegen die Spitze schwach erweitert, Hintertarsen fast nie so lang wie die Schiene,

meistens zwei Drittel bis drei Viertel, Metatarsus der Hinterfüsse immer länger als die zwei folgenden Glieder zusammen. Der Typus der Gattung ist *C. straminea* Redtb.

Die zahlreichen Arten sind über Süd- und Ostasien und die zugehörigen Inseln verbreitet.

Von *Cteniopus* Sol. unterscheidet sich die Gattung durch die nicht aneinanderstehenden Vorderhüften, von *Cteniopinus* Seidl. durch das vorn gerandete 1. Hinterleibssegment und den allseitig scharf gerandeten Halsschild und von *Cistelina* Seidl. durch das Fehlen des 6. Abdominalsegments.

Von den Philippinen waren bisher 7 Arten bekannt. In der folgenden Bestimmungstabelle sind einige nahe verwandte Arten anderen Fundortes der Vollständigkeit halber mit aufgeführt. Die Aufstellung einer Tabelle findet in der verhältnismässigen Variabilität mancher Arten bedeutende Schwierigkeiten.

Bestimmungstabelle.

I (II) Flügeldecken mit normaler Skulptur.

1 (38) Oberseite ohne dunkle Zeichnungen oder Flecke.

2 (29) Flügeldecken ohne deutlich hellere Zwischenräume.

3 (4) Oberseite rot. Länge 13 bis 14.5 mm. Wenig glänzend; schwefelgelb, zwei Analsegmenten wenig dunkler, Beine und Halsschild rötlich, Fühler mit Ausnahme des Grundgliedes schwarz, 2. Glied bräunlich; 3. Fühlerglied länger als das 4.; Augenabstand 1½ Durchmesser. Halsschild wenig gewölbt, mit sehr dichten, feinen Nabelpunkten. Celebes........................ *C. hæmoptera* Bm.

4 (3) Oberseite nicht ausgesprochen rot.

5 (20) Beine einfarbig hell.

6 (13) Bauch ohne dunkle Analsegmente, letzte Glieder höchstens leicht braun.

7 (8) Mehr als drei Grundglieder der Fühler hell. Länge 11.5 mm. Gelb, letztes Segment und der Hinterrand des vorletzten bräunlich, Fühler glieder meist bis zur Spitze des 7. hell, folgende dunkel oder mit heller Basis; 3. Glied deutlich länger als das 4. Zwischenräume der Punktstreifen auf den Flügeldecken an Breite wenig verschieden. Mindanao und Engaño. *C. distincticornis* Pic.

8 (7) Höchstens drei Grundglieder der Fühler hell.

9 (12) Drei Glieder hell.

10 (11) Käfer blass schwefelgelb, 3. Fühlerglied wenig länger als das 4. Länge 12 mm. Nicht glänzend, Flügeldecken wenig heller als der Vorderkörper, Fühler schwarz, zwei letzte Hinterleibsringe schwach rötlich. Augenabstand nicht ganz zwei Durchmesser; 3. Fühlerglied um die Hälfte länger als das 4.; Halsschild fast halbkreisförmig, sehr fein und sehr dicht punktiert; Zwischenräume der Punktstreifen sehr verschieden breit, sehr fein und sehr dicht punktiert. Luzon........................ *C. anæmatica* Bm.

11 (10) **Käfer dunkler; 3. Fühlerglied ein Drittel länger als das 4.; Vorderschienen des Männchens an der Aussenspitze mit zahnartiger Erweiterung. Erweiterung stark. Länge 11 bis 12 mm. Schlank leicht seidenglänzend; gelb, zwei letzte Hinterleibsringe schwach bräunlich, 4. bis 11. Fühlerglied schwarz. Augenabstand des Männchens ein Durchmesser. Luzon und Panay.**
C. insularis sp. nov.
Zahnartige Erweiterung schwächer. Länge 10.5 mm. Etwas kleiner, weniger gewölbt, Kopf länger, Augenabstand geringer. Palawan .... *C. difficilis* sp. nov.

12 (9) Zwei Grundglieder hell. Gelb, Fühler schwarz; Kopf wenig gestreckt; Augenabstand wenig mehr als ein Durchmesser; 3. und 4. Fühlerglied fast gleich. Zwischenräume der Punktstreifen fast flach, an Breite wenig verschieden. Süd-Celebes.
C. modesta sp. nov.

13 (6) Bauch mit zwei meist glänzend schwarzen Analsegmenten. Halsschild und Flügeldecken gelb.

14 (19) Mindestens drei Grundglieder der Fühler hell.

15 (16) Zwischenräume der Punktstreifen an Breite wenig verschieden. Länge 11 mm. Gelb, letztes Segment und der Hinterrand des vorletzten, Fühler mit Ausnahme der 3 Grundglieder und der Basis des 4. Gliedes schwarz; 3. Glied ein Drittel länger als das 4.; Zwischenräume fein raspelartig punktiert, Flügeldeckenspitzen zusammen abgerundet. Biliran........ *C. bilirana* sp. nov.

16 (15) Zwischenräume abwechselnd breiter.

17 (18) Oberseite ziemlich stark glänzend, wenig dicht behaart. Länge 11 bis 14 mm. Gelblich bräunlich, letztes und vorletztes Hinterleibssegment zum Teil glänzend schwarz. Augenabstand ein und ein halb Durchmesser; 3. Fühlerglied mindestens ein Viertel länger als das 4. Punktstreifen ziemlich fein, stark vertieft; Zwischenräume ziemlich gewölbt. Mindanao, Luzon, u. s. w.
C. philippinensis sp. nov.

18 (17) Oberseite fast ganz matt; sehr dicht und kurz behaart. Länge 11 bis 12 mm. Länglich oval. Halsschild dicht punktiert; Kopf lang, Flügeldecken stark gestreift-punktiert; Zwischenräume etwas gewölbt, fein punktiert; vorletztes Segment in der Mitte schwarz, an den Seiten gelb, letztes schwarz. Käfer gelblich, Fühler vom 4. Gliede an schwarz. (Nach der Beschreibung.) Celebes .... *C. minahassana* Pic.

19 (14) Zwei Grundglieder hell. Flügeldecken mit schmalem, rotem Rand. Länge 17 mm. Stark gewölbt; gelb, Halsschild wenig dunkler, Flügeldecken zitronengelb, äusserster Zwischenraum und die Epipleuren rötlich, Punktstreifen dunkel, Fühler bis auf die zwei Grundglieder und das Analsegment schwarz. Augenabstand zwei Durchmesser; 3. Fühlerglied um die Hälfte länger als das 4. Java .... *C. limbata* sp. nov.

20 (5) Schienen und Füsse schwarz.

21 (24) Bauch hell.

22 (23) Hinterleib gelb. Länge 10.5 mm. Siehe 11 (10)!
C. difficilis sp. nov.

23 (22) Hinterleib gegen die Spitze rötlich. Länge 13 bis 16 mm. Ziemlich gewölbt; letztes Drittel der Flügeldecken länger, mehr abstehend, dunkel behaart; gelb, Beine etwas rötlich, Hinterteil des Kopfes, Halsschild, meist drei Grundglieder der Fühler stark rötlich, der übrige Teil der Fühler und die zwei letzten Segmente mehr oder weniger glänzend schwarz. Bei den meiten Tieren sind die ungeraden Zwischenräume dunkler. Augenabstand nicht ganz zwei Durchmesser. 3. Fühlerglied um die Hälfte länger als das 4. Luzon, Mindanao, u. s. w.
C. brevehirsuta Pic.

24 (21) Zwei Analsegmente dunkel.

25 (26) Die ungeraden Zwischenräume der Punktstreifen erhabener und meist dunkel. Siehe 23 (22)! .... *C. brevehirsuta* Pic.

26 (25) Die Zwischenräume nicht so.

27 (28) Vorderkörper gelb, Flügeldecken schwach rötlich, Fühler mit 2 hellen Grundgliedern. Länge 10 mm. Mässig glänzend, seidenartig behaart. Gelb, Flügeldecken bräunlich- bis rötlichgelb, Schienen, Füsse und die zwei letzten Segmente schwarz. Augenabstand 1½ Durchmesser. 3. Fühlerglied ein Drittel länger als das 4. Philippinen .... *C. sericea* sp. nov.

28 (27) Oberseite einfarbig. Länge 10.5 mm. Behaarung nicht seidig. Fühler mit Ausnahme der zwei Grundglieder, Schienen und Tarsen und die zwei letzten Segmente schwarz. Augenabstand ein Durchmesser. 3. Fühlerglied wenig länger als das 4. Zwischenräume der Punktstreifen stark ungleich. Celebes, Bonthain.
C. ribbei sp. nov.

29 (2) Dritter, 5. und 7. Zwischenräum der Punktstreifen deutlich heller, meist breiter. stärker gewölbt.

30 (33) Abdomen einfarbig hell.

31 (32) Nur zwei Grundglieder der Fühler hell, Schienen und Füsse dunkel. Länge 10 mm. Schwefelgelb, stärker erhabene Zwischenräume heller, Abdomen, rötlich. Drittes Fühlerglied um die Hälfte länger als das 4. Halsschild fast halbkreisförmig, fein und sehr dicht punktiert; Analsegment mit einer tiefen, dreieckigen Grube vor der Spitze. Sibay...... *C. rufiventris* Bm.

32 (31) Drei Grundglieder der Fühler hell, Schienen und Füsse hell. Länge 10 bis 11.5 mm. Stark gewölbt; schwefelgelb, zwei Analsegmente braun, Vorderkörper etwas rötlich. 3. Fühlerglied länger als das 4. Halsschildseiten in der 1. Hälfte leicht ausgeschweift. Nur der 2. Zwischenraum reicht bis zur Spitze. Buru .... *C. toxopei* sp. nov.

33 (30) Abdomen mit dunklen Segmenten.

34 (37) Halsschild rot.

35 (36) Flügeldecken gelb, zwei Analsegmente dunkel. Länge 15 mm. Drei Grundglieder der Fühler hell, gelb, Halsschild und Beine rot, Flügeldecken gelb, ungerade Zwischenräume gewölbt, breiter und dunkler; 3. Fühlerglied ein Drittel länger als das 4. Halsschildseiten nahe der Basis gerundet erweiter. Luzon.
C. rutilicollis sp. nov.

36 (35) Flügeldecken rotbraun, nur ein Analsegment schwarz. Länge 14 mm. Rötlichgelb, Hinterteil des Kopfes und das Halsschild rot, ungerade Zwischenräume der Flügeldecken gelb und schmäler. Drei Grundglieder der Fühler hell, Füsse gegen die Spitze angedunkelt. Dreittes Fühlerglied ein Drittel länger als das 4. Süd-Celebes .... *C. festiva* sp. nov.

37 (34) Halsschild und Flügeldecken gelb.

Länge 9 bis 10.5 mm. Die kurzen Borsten auf dem letzten Drittel der Flügeldecken dunkel, mehr abstehend; schwach bräunlichgelb, Schienen und Füsse, zwei Analsegmente und die Fühler bis auf die 2 Grundglieder schwarz. Kopf stark gestreckt, Hals längsrissig punktiert; 3. Fühlerglied sehr wenig länger als das 4.; ungerade Zwischenräume breiter und gewölbter. Manila .... *C. caligata* sp. nov.

Länge 10 bis 11 mm. Gelb behaart; Färbung wie vorher, gerade Zwischenräume oft dunkler. Augenabstand geringer als bei *caligata;* Fühler länger, 3. Glied deutlich länger als das 4.; Zwischenräume fast gleichbreit, ungerade stärker gewölbt. Luzon .... *C. mimula* sp. nov.

38 (1) Oberseite mit dunklen Zeichnungen oder Flecken.

39 (40) Flügeldecken rot, auf dem letzten Viertel ein grosser, ziemlich lang schwarz behaarter schwarzer Fleck. Länge 13 bis 15 mm. Oval, stark gewölbt; Flügeldecken etwas dachförmig. Oberseite lebhaft gelbrot, Fühler mit Ausnahme der drei Grundglieder und zwei Analsegmente schwarz, Beine rötlich, Kniee, Spitze der Schienen und der Tarsenglieder schmal gebräunt. Luzon.
C. semipellita Bm.

40 (39) Flügeldecken gelb, mit schwarzen Zeichnungen.

41 (44) Flügeldecken nur mit linienförmigen Zeichnungen.

42 (43) Drei Grundglieder der Fühler hell, Halsschild braun, Schienen und Füsse hell, Analsegmente hell. Länge 10 bis 11 mm. Schwarzbraun, Kopf mit Ausnahme des Halses, Schildchen und Beine bräunlichgelb, 2., 4. und oft 6. Zwischenraum dunkelbraun, dunkle Streifen erreichen nicht die Basis und Spitze, ihre Länge von innen nach aussen abnehmend, Unterseite und Halsschild zuweilen heller. Luzon .... *C. atricollis* Pic.

43 (42) Zwei Grundglieder hell, Halsschild rot, Schienen und Füsse schwarz, zwei Analsegmente dunkel. Länge 13 mm. Länglichoval, wenig glänzend. Gelb, Flügeldecken mit braunen Linien, Kopf und Halsschild rot, Fühler mit Ausnahme der zwei roten Grundglieder, Schienen, Tarsen und zwei Analsegmente schwarz. Halsschild dicht punktiert, Flügeldecken gestreift-punktiert, Zwischenräume zum Teil gewölbt. (Übersetzung der Beschreibung.) Manila.. *C. brunneolineata* Pic.

44 (41) Flügeldecken im 8. Zwischenraum hinter der Schulter mit kurzer, schwarzer Linie und im 3. bis 8. am Anfang des letzten Drittels mit einer schrägen, gebogenen, vorn offenen Querbinde, die weder die Naht, noch den Rand berührt. Länge 9 bis 12 mm. Schwefelgelb, Schienen und Füsse, die beiden Analsegmente, die

Taster und die Fühler mit Ausnahme des 1. Gliedes schwarz, Oberlippe gebräunt, Halsschild etwas rötlich. Buru.
C. martini Pic.

II (I) Flügeldecken mit abnormer Skulptur. Länge 11.5 mm. Gelb, Vorderkörper und drei Fühlerwurzelglieder rotbraun, Schienen und Füsse schwarzbraun, zwei Analsegmente glänzend schwarz; Augenabstand fast zwei Durchmesser; 3. Fühlerglied um die Hälfte länger als das 4.; Punktstreifen der Flügeldecken stark, etwas dunkler, 2. und 3. Zwischenraum im letzten Drittel stark erweitert und stark nach aussen gebogen, 2. Punktstreif vor der Spitze mit 7. vereinigt, 3. mit 6., 1. erreicht die Spitze, 4. und 5. enden frei, Skulptur im letzten Fünftel gänzlich gestört. Ost-Bali .... *C. anastomosis* sp. nov.

BESCHREIBUNGEN

Durch die Güte des Herrn M. Pic lagen mir die Typen von *C. brevehirsuta* Pic, *C. distincticornis* Pic und *C. holoxantha* Pic vor. Von den beiden erstgenannten Arten habe ich mir gestattet, unter Hinzuziehung meines eigenen Materials ausführliche Beschreibungen zu geben. *C. holoxantha* Pic gehört in die Gattung *Cteniopinus*. Das mir vorliegende, sehr schlecht erhaltene Stück scheint derselben Art anzugehören wie *C. kwanhsienensis* Bm.

CISTELOMORPHA DISTINCTICORNIS Pic.

Länge 11.5 mm. Form wie *C. bilirana* m.; mässig glänzend; gewölbt; sehr kurz, fein, anliegend hell behaart, Flügeldecken im letzten Drittel mit kurzen, anliegenden, schwarzen Haaren; Färbung sehr ähnlich, aber Fühler hell, Spitze des 7. und die übrigen Glieder schwarz. Kopf wie bei *bilirana*, Endglied der Kiefertaster weniger schräge abgestutzt, Kopf wenig dicht, ziemlich stark punktiert; Oberlippe etwas quer herzförmig; Clypeus nach vorn leicht verengt, etwas gewölbt, von der Stirn durch eine gebogene breite Furche getrennt; Stirn der Länge nach schmal eingedrückt; Schläfen sehr kurz; Hals deutlich abgeschnürt; Augen normal, Abstand ein und ein halb Durchmesser; Fühler die Körpermitte lange nicht erreichend, schlank, leicht gesägt, Grundglied vier mal so lang wie an der Spitze breit, 2. ein Drittel so lang wie das 1., 3. gestreckt, gebogen, so lang wie das 2. und 3. zusammen, deutlich länger als das 4., Glieder vom 4. an lang dreieckig, wenig verkürzt, 11. so lang wie das 10. Halsschild wenig gewölbt, uneben, fast doppelt so breit wie lang, sehr dicht mittelstark punktiert, allseitig gerandet, Basis kräftig geschwungen, fein gerandet, Ecken kurz

gerundet rechteckig, leicht aufgebogen, Seiten bis zur Mitte schwach geradlinig erweitert, dann schnell gerundet verengt, Vorderecken verrundet, Apex ein Drittel der Basis, Mittelfurche nur in der ersten Hälfte, breit und flach. Schildchen spitz, lang dreieckig, fein und dicht punktiert. Flügeldecken gewölbt, nach hinten etwas erweitert, ziemlich glänzend, Punktstreifen mittelstark, Punkte rund und dicht, in der Spitze feiner; Zwischenräume schwach gewölbt, dicht und nicht sehr fein punktiert, 3., 5. und 7. etwas breiter; Schultern kräftig; Spitzen einzeln sehr kurz gerundet; Epipleuren vorn mässig breit, ausgehöhlt, vor der Spitze schwindend, sehr fein punktiert, im letzten Drittel mit zerstreuten, kurzen, schwarzen Härchen. Unterseite glänzender, sehr fein punktiert. Beine normal, Schienen sehr schwach gebogen; Metatarsus der Hinterfüsse etwas länger als die zwei folgenden Glieder zusammen; Enddorne der Hinterschienen gewöhnlich.

MINDANAO, Bukidnon, Dapitan, Lindabon (*W. Schultze*), 3 Exemplare; Surigao (*Baker, 15824*) 1 Exemplar; LUZON, Mount Banahao (*G. Böttcher*), 1 Exemplar in meiner Sammlung.

Bei dem letzten Tiere sind die zwei letzten Hinterleibsringe rötlich, und die Behaarung der Oberseite ist etwas länger. Die Type stammt von Engaño.

CISTELOMORPHA INSULARIS sp. nov.

Länge 11 bis 12 mm. Schlank, gewölbt, leicht seidenglänzend, sehr fein, ziemlich dicht und kurz, anliegend, gelb behaart; gelb, die zwei letzten Hinterleibsringe bräunlich getrübt, 4. bis 11. Fühlerglied schwarz. Kopf mässig gestreckt, sehr dicht und ziemlich stark punktiert; Oberlippe flach, querherzförmig, gegen die Basis schwach verengt; Clypeus quer, flach, nach vorn wenig verschmälert, von der Stirn durch eine flache, gebogene Furche getrennt; Stirn schwach gewölbt; Schläfen sehr kurz, beim Männchen fast ganz geschwunden; Endglied der Kiefertaster gegen die Spitze sehr schwach verbreitert, wenig schräge abgestutzt, an der Spitze getrübt; Mandibelspitzen dunkel; Augen stark gewölbt, Abstand ein Durchmesser, beim Weibchen etwas mehr; Halsfurche deutlich. Fühler schlank, schwach gesägt, so lang wie der halbe Körper, beim Weibchen etwas kürzer, 1. Glied dreimal so lang wie an der Spitze breit, 2 ein Drittel so lang, 3. ein und ein Drittel mal so lang wie das 1. und 2. zusammen, an der Spitze etwas knotig verdickt, schwach gebogen, sehr deutlich länger als das 4., die folgenden Glieder

unter sich fast gleich, Endglied so lang wie das 10., stark eingeschnürt. Halsschild ziemlich gewölbt, nicht ganz doppelt so breit wie lang, vorn oft mit feiner Mittellinie, Basis mit den gewöhnlichen Eindrücken und Ausbuchtungen, Basis kaum erkennbar. Seiten scharf, Apex sehr fein gerandet, Scheibe mit sehr dichten, mittleren Augenpunkten, Seiten bis zur Mitte fast gerade, kaum verengt, von der Mitte ab fast geradlinig stark nach vorn zusammenlaufend, Vorderecken verrundet, Basisecken sehr kurz gerundet rechtwinklig, oft etwas nach hinten vorgezogen, Apex fast gerade, hinter den Augen sehr leicht ausgerandet und eingedrückt, etwa halb so lang wie die Basis. Schildchen breit zungenförmig, sehr dicht punktiert. Flügeldecken beim Männchen dreimal so lang wie der Halsschild, nach hinten kaum erweitert, mässig gewölbt, Punktstreifen kräftig, etwas vertieft, Punkte länglich, dicht, in der Spitze kaum feiner; Zwischenräume leicht gewölbt, in der Spitze und an den Rändern etwas stärker, fast gleich breit, sehr dicht, fein, etwas raspelartig punktiert; Schultern kräftig; Spitzen sehr kurz einzeln gerundet; Epipleurem vorn ziemlich breit, unvollständig, sehr fein und dicht punktiert. Unterseite fein und sehr dicht punktiert und kurz behaart; Schenkel etwas flach, verhältnismässig breit, Schienen wenig gebogen, gegen die Spitze verbreitert, Enddorne der Hinterschienen normal; Vorderschienen des Männchen aussen an der Spitze kurz und breit zahnartig erweitert, Aussenrand im letzten Viertel schneidend; Hinterschenkelspitze den Hinterrand des 3. Segments wenig überragend; Metatarsus der Hinterfüsse etwas länger als die zwei folgenden Glieder zusammen; Analsegment des Weibchens fast gerade abgestutzt, das Männchen hat ein 6. Segment, das an dem breit abgestutzten Hinterrande beiderseits seicht ausgerandet ist und in der Mitte eine schmale Längsfurche zeigt.

LUZON, Mount Banahao (*G. Böttcher*), 6 Exemplare; SIBUYAN (*Baker*), 1 Exemplar. PANAY, Antique, Culasi (*McGregor*), 3 Exemplare in der Sammlung W. Schultze. 3 Tiere im Museum in Dresden stammen von Luzon, Mount Maquiling (*Baker 4634* und *7397*), Mount Banahao (*Baker 4611* und *4617*). Unter *4634* erhielt ich von Herrn Prof. Baker ein Tier, das zu *C. philippinensis* sp. nov. gehört. LUZON, Mount Maquiling (*Baker, 4634, 7397*) und Mount Banahao (*Baker, 4611*), 3 Tiere im Museum in Dresden.

Die Art ist verwandt mit *C. distincticornis* Pic.; aber diese ist breiter, gewölbter, viel glänzender, schwächer behaart und anders gefärbt. Ihre Vorderschienen haben keine zahnartige Erweiterung.

CISTELOMORPHA DIFFICILIS sp. nov.

Länge 10.5 mm. Mässig gewölbt, mässig glänzend; kurz, fein, anliegend, gelblich behaart; gelb, Fühler mit Ausnahme der 3 Grundglieder schwarz. Kopf normal; Oberlippe leicht quer; Mundteile gewöhnlich; Augenabstand etwas mehr als ein Durchmesser, sonst der *C. insularis* m. ausserst ähnlich, aber etwas kleiner, weniger gewölbt, Kopf etwas länger, Augenabstand geringer, Halsschild etwas länger, weniger stark gewölbt, Apex schmäler, beim Männchen die Erweiterung der äusseren Vorderschienenecke schwächer.

PALAWAN, 1 Männchen in meiner Sammlung.

CISTELOMORPHA PALAWANICA sp. nov.

Länge 10 mm. Mässig gewölbt, mässig glänzend, Behaarung normal; gelb, Fühler mit Ausnahme der zwei Grundglieder, Schienen und Tarsen schwarz, die zwei letzten Hinterleibssegmente angedunkelt. Kopf stark gestreckt, Oberlippe normal; Clypeus so lang wie breit; Halsfurche ziemlich deutlich; Schläfen sehr kurz; Taster normal, angedunkelt; Augenabstand ein und ein halb Durchmesser; Fühler schlank, halb so lang wie der Körper, 3. Glied wenig länger als das 1., etwas länger als das 4. Halsschild etwas länger als die halbe Basis, mit sehr dichten, kräftigen Augenpunkten, Seiten fast bis zur Mitte parallel, dann gerundet verengt, Apex etwas kürzer als die halbe Basis, Basisecken äusserst kurz gerundet rechtwinklig. Schildchen spitz zungenförmig. Flügeldecken mässig gewölbt, sehr wenig erweitert, mit den gewöhnlichen Punktstreifen, Zwischenräume wenig gewölbt, an Breite stark verschieden, Schultern und Epipleuren normal, Spitzen ziemlich breit einzeln gerundet. Analsegment gerade abgestutzt; Hintertarsen fehlen.

SÜD-PALAWAN, 1 Männchen in meiner Sammlung.

Die Art ist nahe mit *C. sericea* m. verwandt; aber bei dieser ist der Kopf kürzer und gröber punktiert, das 3. Fühlerglied bedeutend länger als das 1. und 4. Der Halsschild ist kaum so lang wie die halbe Basis und von der Basis fast bis zur Mitte leicht erweitert. Die Flügeldecken sind dunkler als der Vorder-

körper, die Spitzen weniger breit gerundet, die Vorderschiene gebogen, das Analsegment ist breit gerundet abgestutzt.

CISTELOMORPHA MODESTA sp. nov.

Länge 11.5 mm. Länglich-oval, mässig gewölbt, normal behaart, wenig glänzend; gelb, Fühler mit Ausnahme der zwei Grundglieder schwarz. Kopf weniger gestreckt, mässig stark, sehr dicht punktiert; Oberlippe quer, Stirn wenig gewölbt; Augenabstand wenig mehr als ein Durchmesser; Schläfen fast geschwunden; Halsfurche deutlich; Fühler gewöhnlich, 3. und 4. Glied fast gleich, 3. um die Hälfte länger als das 1. Halsschild wenig länger als die Basishälfte, sehr dicht und fein punktiert, Mittelrinne nicht erkennbar, Eindrücke sehr schwach, Seiten von der Basis bis zum Anfang des 2. Drittels schwach gerundet erweitert, dann stärker gerundet verengt, Apex mindestens so breit wie die halbe Basis, Vorderecken nicht ganz verrundet, Basisecken abgerundet stumpwinklig. Schildchen spitz zungenförmig. Flügeldecken wenig gewölbt, nach hinten schwach erweitert, Punktstreifen fein, wenig vertieft; Zwischenräume fast flach, sehr dicht und fein punktiert. Hintertarsen zwei Drittel der Schiene; Metatarsus der Hinterfüsse fast so lang wie die folgenden Glieder zusammen. Analsegment an der Spitze gerade abgestutzt, am Hinterrande flach und breit dreieckig eingedrückt.

SÜD-CELEBES, Bonthain (*C. Ribbe*), 1 Männchen in meiner Sammlung.

Die Art ähnelt der *C. insularis* m., ist aber kürzer und breiter. Die Fühler sind kräftiger und haben kürzere Glieder. *Cistelomorpha insularis* hat nur ein helles Fühlergrundglied. Die Männchen haben eine zahnartige Erweiterung an der äusseren Spitze der Vorderschienen.

CISTELOMORPHA BILIRANA sp. nov.

Länge 11 mm. Form gewöhnlich, ziemlich stark gewölbt; ziemlich kurz, anliegend gelb, das letzte Viertel der Flügeldecken etwas länger und dunkler behaart; gelb, letztes Segment und wenigstens der Hinterrand des vorletzten und die Fühler mit Ausnahme der drei ersten und der Basis des 4. Gliedes schwarz; wenig glänzend. Kopf stark gestreckt, mässig dicht und mittelstark punktiert, Oberlippe fast quadratisch, ausgerandet; Clypeus so lang wie breit, nach vorn wenig verengt, wenig gewölbt, vorn gerade, von der Stirn normal getrennt; Endglied der Kiefertaster lang, nach vorn wenig verbreitert, schräg abgestutzt,

Endglied der Lippentaster schief viereckig; Stirn gewölbt, in der Mitte vorn mit kurzer, flacher Längsfurche; Schläfen äusserst kurz; Hals deutlich abgeschnürt; Augen stark gewölbt, ausgerandet, Abstand fast zwei Durchmesser; Fühler die Körpermitte nicht erreichend, ziemlich dünn, schwach gesägt, 3. Glied ein Drittel länger als das 4., folgende Glieder wenig kürzer, 11. zugespitzt, so lang wie das 10.; Halsschild fast halbkreisförmig, wenig gewölbt, sehr dicht und ziemlich fein punktiert, an der Basis mit kurzer, flacher, breiter Mittelfurche, Seiten flach, Basis mit den gewöhnlichen Buchtungen, Seiten bis zur Mitte schwach und fast gerade verengt, Vorderecken breit verrundet, Basiswinkel rechteckig, sehr kurz abgerundet, Seiten scharf gerandet, Apex fast gerade, nicht halb so breit wie die Basis, sehr fein, Basis wenig stärker gerandet. Schildchen normal. Flügeldecken breiter als die Halsschildbasis, nach hinten wenig erweitert, mit starken Punktstreifen, Punkte rund und sehr dicht, in der Spitze feiner; Zwischenräume gewölbt, an Breite wenig verschieden, dicht, etwas raspelartig punktiert; Schultern kräftig; Spitzen zusammen abgerundet; Epipleuren vorn ziemlich breit, allmählich verengt, unvollständig, sehr fein punktiert, oberer Rand am Ende des ersten Drittels ziemlich breit. Unterseite normal; Schenkel wenig dick, Schienen fast gerade; Metatarsus der Hinterfüsse länger als die zwei folgenden Glieder zusammen; Enddorne der Hinterschienen dünn und spitz, der innere länger.

BILIRAN (*R. C. McGregor*), 2 Exemplare in der Sammlung W. Schultze.

Die Art hat eine gewisse Verwandtschaft mit *C. anæmatica* Bm. Diese ist blasser, die Basis des 4. Fühlergliedes ist dunkel, die Hinterleibsspitze hell. Ihr Halsschild *C. bilirana* ist viel stärker gewölbt und an den Seiten viel gleichmässiger gerundet. Die Zwischenräume der Punktstreifen auf den Flügeldecken sind ungleich breit.

CISTELOMORPHA PHILIPPINENSIS sp. nov.

Länge 11 bis 14 mm. Ziemlich gewölbt, mässig glänzend; gelblich bräunlich, mindestens drei, oft mehr Grundglieder der Fühler hell, der übrige Teil schwarz, vorletztes Hinterleibssegment teilweise, das letzte ganz schwarz; dicht, fein, anliegend, ziemlich kurz gelb behaart. Kopf ziemlich stark und dicht punktiert, Stirn stark gewölbt, leicht eingedrückt, Halsfurche flach; Mundteile normal; Augenabstand ein und ein halber

Durchmesser. Fühler die Körpermitte nicht ganz erreichend, 1. und 4. Glied gleich lang, 3. mindestens ein Viertel länger als das 4. Halsschild ziemlich gewölbt, etwas länger als die halbe Basis, mit sehr feinen Nabelpunkten sehr dicht besetzt, Mittelfurche undeutlich, Basis normal, Eindrücke flach, Seiten von der Basis bis zur Mitte sehr schwach gerundet erweitert, dann gerundet verengt, Apex schmäler als die halbe Basis, Basisecken kurz gerundet rechtwinklig; Schildchen lang zungenförmig. Flügeldecken deutlich breiter als der Halsschild, sehr dicht und fein, etwas raspelartig punktiert, Punktstreifen ziemlich fein, stark vertieft, Zwischenräume ziemlich gewölbt, stark ungleich breit; Schultern, Spitzen und Epipleuren normal. Unterseite und Beine gewöhnlich; Hintertarsen kürzer als die Schiene; Metatarsus etwas länger als die zwei folgenden Glieder zusammen.

MINDANAO, Momungan, Tangkulan (*Böttcher*), Dapitan (*Baker*); LUZON, Mount Banahao (*Böttcher*) (*Baker, 4634*), 10 Exemplare in meiner Sammlung. LUZON, Mount Maquiling (*Baker*), 2 Exemplare im Museum in Dresden.

Die Art ist mit *C. minahassana* Pic von Celebes verwandt, ist aber robuster und dunkler gefärbt. Bei *C. minahassana* ist das Grundglied der Fühler nur halb so lang wie das 4. Fühlerglied. Die Flügeldecken sind fast glanzlos, und der Halsschild ist flacher. Es ist nicht unmöglich, dass diese Art vom Kollegen Pic als *C. distincticornis* beschrieben wurde. Aber die Beschreibung findet sich nur in einer nicht ganz klaren Tabelle, aus der hervorzugehen scheint, dass der Kopf schwarz sein soll. Vielleicht gründet sich die Beschreibung auf ein verdorbenes Stück. Jedenfalls haben meine Tiere keinen schwarzen Kopf, zwei schwarze Hinterleibsringe und in der übergrossen Mehrzahl anders gefärbte Fühler.

CISTELOMORPHA LIMBATA sp. nov.

Länge 17 mm. Länglich-oval, stark gewölbt, mässig glänzend, sehr fein, kurz, fast anliegend gelb behaart, unten seidig, gelb, Halsschild wenig dunkler, Flügeldecken zitronengelb, äusserster Seitenrand und Epipleuren rötlich, Fühler bis auf die zwei Grundglieder und das letzte Hinterleibssegment schwarz, Kieferspitzen und Endglied der Taster angedunkelt. Kopf normal, Clypeus und Stirn dicht und grob, stellenweise zusammenfliessend punktiert; Mundteile normal; Augenabstand zwei Durchmesser; 1. und 4. Fühlerglied gleich lang, 3. um die Hälfte

länger. Halsschild bedeutend länger als die halbe Basis, wenig gewölbt, Mittelfurche flach und ziemlich schmal, mit sehr dichten, starken Augenpunkten besetzt, Basiseindrücke flach, Seiten bis zur Mitte sehr schwach gerundet erweitert, dann gleichmässig gerundet verengt, Apex viel schmäler als die halbe Basis, Basisecken ziemlich breit gerundet, flach. Schildchen rötlich, fast gleichseitig dreieckig, Spitze kurz gerundet. Flügeldecken bis zum Anfang des letzten Viertels schwach erweitert, dann gerundet verengt, hinter dem Schildchen die Naht kurz eingedrückt, sehr fein, wenig dicht punktiert, Punktstreifen etwas dunkler; Schulterbeule, Spitzen und Epipleuren gewöhnlich. Prosternalfortsatz wenig höher als die Hüften, oben breit. Hintertarsen kürzer als die Schiene, Metatarsus der Hinterfüsse so lang wie die zwei folgenden Glieder zusammen.

JAVA (*Felsche*), 2 Exemplare, 1 im Museum in Dresden und 1 in meiner Sammlung.

Die Art hat eine gewisse Ähnlichkeit mit *C. straminea* Redtb. von China; aber diese hat schwarze Tarsen; ihre Fühler haben drei helle Grundglieder, und die Zwischenräume der Punktstreifen sind schuppig punktiert.

CISTELOMORPHA BREVEHIRSUTA Pic.

Länge 13 bis 16 mm. Länglich-oval ziemlich gewölbt, mässig glänzend; fein, anliegend, kurz, gelblich, im letzten Drittel der Flügeldecken länger, mehr abstehend, dunkel behaart, unten seidenartig; gelb, Beine etwas rötlicher, Hinterteil des Kopfes, Halsschild, meist drei Grundglieder der Fühler rötlich, der übrige Teil der Fühler und die zwei letzten Hinterleibssegment schwarz, Endglieder der Taster angedunkelt; bei den meisten Tieren sind die ungeraden Zwischenräume der Punktstreifen dunkler. Kopf normal; Oberlippe leicht quer, Stirn gewölbt und der Länge nach schwach eingedrückt; 1. Glied der Lippentaster dem der Kiefertaster sehr ähnlich; Augenabstand zwei Durchmesser oder etwas weniger; Fühler kräftig, die Körpermitte lange nicht erreichend, 1. und 4. Glied gleich lang, 3. um die Hälfte länger als das 4. Halsschild etwas länger als die halbe Basis, mit sehr dichten, mittleren Augenpunkten; Mittelrinne flach, deutlich, Seitenrand gleichmässig gerundet verengt, Basis mit den gewöhnlichen Buchtungen und Eindrücken, Apex viel schmäler als die halbe Basis, Basisecken breit abgerundet rechtwinklig. Schildchen dreieckig, Spitze abgerundet. Flügeldecken kräftig gewölbt, etwas dachförmig, nach hinten bis zum letzten Viertel wenig erweitert, dann gerundet verengt; Punkt-

streifen mittel, sehr dicht punktiert; Zwischenräume gewölbt, sehr dicht, leicht querrunzelig punktiert, die ungeraden stärker gewölbt und breiter, Seitenrand hinter den Schultern verbreitert; Schultern, Epipleuren und Spitzen normal. Unterseite gewöhnlich, Prosternalfortsatz oben flach. Hintertarsen kürzer als die Schiene, Metatarsus der Hinterfüsse wenig länger als die 2 folgenden Glieder zusammen.

LUZON, Imugan, 7 Exemplare, Trinidad, 1 Exemplar; MINDANAO, Surigao, 7 Exemplare, alle von Böttcher gesammelt, in meiner Sammlung; Baguio, Benguet (*Baker*), 1 Exemplar in Dresden.

Das Exemplar von Trinidad ist das grösste, etwas dunkler, mit schwarzbrauner Fühlerwurzel. Die Zwischenräume der Punktstreifen sind kaum verschieden gefärbt. Der Hälsschild ist deutlich kürzer als die halbe Basis; die Eindrücke sind stärker, und die Seiten sind in der erste Hälfte fast gerade, schwach erweitert und dann plötzlich wenig gebogen verengt. Die Oberlippe ist stärker quer. Ich nenne die Varietät *obscuricornis*.

Die Art ist nahe verwandt mit *C. rutilicollis* Bm.; aber die Flügeldecken dieser Art sind viel heller und die geraden Zwischenräume dunkler. Das 1. Fühlerglied ist deutlich länger als das 4., das 3. wenig länger als das 1.; der Halsschild ist so lang wie die halbe Basis, neben der Basis gerundet erweitert und dann verengt. Die Hintertarsen sind kürzer; der Metatarsus der Hinterfüsse ist bedeutend länger als die zwei folgenden Glieder zusammen. *C. festiva* m. hat nur ein dunkles Hinterleibssegment. Sie ist schlanker; ihre Hintertarsen sind so lang wie die Schienen und das Analsegment ist abweichend gebildet.

CISTELOMORPHA SERICEA sp. nov.

Länge 10 mm. Form gewöhnlich; mässig gewölbt, mässig glänzend; seidenartig behaart; gelb, Flügeldecken bräunlichgelb, Fühler mit Ausnahme der zwei Grundglieder, Schienen und Füsse und die zwei letzten Hinterleibsringe schwarz, Mandibelspitzen und Taster dunkel. Kopf stärker glänzend, Clypeus und Stirn gröber und zerstreut punktiert; Oberlippe quer, wenig ausgerandet; Clypeus quer; Halsfurche deutlich; Schläfen äusserst kurz; Augenabstand ein und ein halber Durchmesser; Fühler fast die Körpermitte erreichend, 1. und 4. Glied gleich lang, 3. ein Drittel länger. Halsschild so lang wie die halbe Basis, gewölbt, sehr dicht mit mässig starken Augenpunkten besetzt,

Mittelfurche seicht, Seiten fast bis zur Mitte schwach, etwas gerundet erweitert, dann gerundet verengt, Apex erwas kürzer als die halbe Basis, fast gerade, Basiseindrücke flach. Schildchen zungenförmig. Punktstreifen der Flügeldecken ziemlich fein; Zwischenräume ungleich, wenig gewölbt, sehr dicht und fein punktiert. Prosternalfortsatz gewöhnlich; Hinterfüsse drei Viertel der Schiene; Metatarsus der Hinterfüsse etwas länger als die zwei folgenden Glieder zusammen; Spitze des Analsegments gerundet.

PHILIPPINEN (ohne nähere Bezeichnung), 1 Männchen in meiner Sammlung.

Die Art ist der *C. palawanica* m. recht ähnlich; aber ihr Kopf ist kürzer. Der Halsschild ist bei *palawanica* länger als die halbe Basis, und ihre Flügeldecken sind viel weniger dicht punktiert. Bei der ebenfalls sehr ähnliche *C. caligata* m. (*mimula*) ist der Halsschild viel stärker gewölbt, die Zwischenräume der Punktstreifen sind ungleich hoch, die Seiten des Halsschildes nicht erweitert, und das Analsegment des Männchens ist viel breiter abgestutzt.

CISTELOMORPHA RIBBEI sp. nov.

Länge 10.5 mm. Der *C. sericea* m. sehr ähnlich; aber die Behaarung erscheint nicht seidenartig. Gelb, Flügeldecken nicht dunkler, Fühler mit Ausnahme der zwei Grundglieder, Schienen, Tarsen und die zwei letzten Hinterleibssegmente schwarz, Kopf zwischen den Augen, Kieferspitzen und Taster dunkel. Clypeus sparsam punktiert; Hals stark abgeschnürt; Augenabstand ein Durchmesser; Schläfen fast geschwunden; 3. Fühlerglied wenig länger als das 4., dieses etwas länger als das 1. Halsschild stark gewölbt, Wölbung an den Seiten nicht bis zum Rande, sehr dicht und stark punktiert, etwas länger als die halbe Basis, Mittelfurche nur angedeutet, Basiseindrücke flach, Seiten fast bis zur Mitte gerade, schwach erweitert, dann gerundet verengt, Basiswinkel kurz abgerundet, Apex so lang wie die halbe Basis. Schildchen sehr kurz abgerundet dreieckig. Punktstreifen der Flügeldecken ziemlich fein, Zwischenräume stark ungleich, mässig gewölbt, dicht, etwas raspelartig punktiert. Hintertarsen drei Viertel der Schiene; Metatarsus der Hinterfüsse sehr wenig länger als die zwei folgenden Glieder zusammen; Analsegment breit gerundet.

CELEBES, Bonthain (*C. Ribbe*, 1882), 1 Weibchen in meiner Sammlung.

Bei *sericea* m. ist der Halsschild kürzer und weniger gewölbt, die Seiten sind auch im 1. Drittel leicht gerundet. Der Kopf ist etwas kürzer, der Augenabstand bedeutend grösser, das 4. Fühlerglied nicht länger als das 1. Die Flügeldecken sind dunkler.

CISTELOMORPHA TOXOPEI sp. nov.

Länge 10 bis 11.5 mm. Länglich, stark gewölbt, mässig glänzend, sehr fein, kurz, anliegend, gelblich behaart; schwefelgelb, die 2 letzten Hinterleibsringe leicht gebräunt, Fühler mit Ausnahme der 2 oder 3 Grundglieder schwarz, Endglied der Kiefertaster und die Oberkieferspitzen gebräunt, Vorderkörper etwas rötlich, die geraden Zwischenräume der Punktstreifen dunkler. Kopf wie bei *martini* Pic, Oberlippe stark quer herzförmig; Clypeus etwas quer, Seiten parallel, von der Stirn undeutlich abgesetzt; Stirn gewölbt; Schläfen fast fehlend; Augen gross, stark gewölbt, stark ausgerandet; Hals schwach abgesetzt; Fühler ziemlich dünn, die Körpermitte nicht erreichend, alle Glieder lang, Form wie bei *martini*, zweiten Glied so lang wie breit, 3. länger und schmäler als das 4., Endglied wie bei *martini*. Halsschild fast doppelt so breit wie lang, äusserst dicht mit kleinen Augenpunkten besetzt, mässig gewölbt, Basis in den Ecken mit je einem Grübchen, Mitte etwas niedergedrückt, grösste Breite in der Mitte, Seiten in der ersten Hälfte etwas ausgeschweift, Apex sehr flach ausgeschnitten, Basis jederseits zweimal geschwungen, Mitte breit und flach vorgezogen, gerandet, Seiten scharf, wie der Apex fein gerandet, Basisecken rechtwinklig, kurz abgerundet, Vorderecken fast ganz verrundet, Apex schmäler als die Basishälfte. Schildchen dreieckig, sehr fein punktiert und behaart. Flügeldecken vorn wenig gewölbt, breiter als die Halsschildbasis, äusserst dicht, höchst fein querrunzelig punktiert, mit kräftigen, dicht punktierten Punktstreifen, Punkte in der Spitze sehr wenig feiner, ungerade Zwischenräume gewölbt, breiter als die geraden, hell, ungerade nicht gewölbt, dunkler, nur der 2. Zwischenraum erreicht fast die Spitze, die andern geraden endigen meist weit vorher, der 4. ist der kürzeste. Spitzen einzeln kurz gerundet; Schultern etwas beulig; Epipleuren schmal, endigen vor der Spitze. Unterseite wie die Oberseite skulptiert, 5. Segment an der Spitze leicht ausgerandet, beim Männchen gerade und etwas flach, das Weibchen zeigt ein kurzes, leicht ausgerandetes 6. Segment, das an der Spitze lang beborstet ist. Beine kräftig, Schenkel breit,

etwas platt, Hinterschenkelspitze erreicht den Hinterrand des 8. Segments; Schienen und Beborstung wie bei *martini* Pic; Hinterfüsse etwas länger als die Hälfte der Schienen; Metatarsus kürzer als die folgenden Glieder zusammen; Prosternalfortsatz gewöhnlich.

Vier Exemplare. Station 1; 10. Februar bis 16. März 1912; 29. März bis 10. April 1921.

Die Art ähnelt der *rutilipes* Bm.; aber diese ist grösser, ihre Beine sind rot, die 2 letzten Segmente schwarz, die Fühler kräftiger; der Halsschild ist in der ersten Hälfte nicht ausgeschweift, die Behaarung schwarz und die Zwischenräume der Punktstreifen auf den Flügeldecken sind nicht verschieden gefärbt. Ich benenne die Art nach ihrem Entdecker, Herrn L. I. Toxopeus.

CISTELOMORPHA RUTILICOLLIS sp. nov.

Länge 15 mm. Länglich-oval; ziemlich stark gewölbt, mässig glänzend; sehr fein, kurz, dicht, anliegend, gelblich behaart; gelb, Vorderkörper und Beine und die drei Grundglieder der sonst schwarzen Fühler rot, Schienen und Füsse dunkel, die zwei letzten Hinterleibsringe glänzend schwarz, die geraden Zwischenräume der Punktstreifen flach, schmäler und heller als die ungeraden. Kopf und Mundteile normal; Augenabstand zwei Durchmesser; Fühler erreichen kaum die Körpermitte, 3. Glied bedeutend länger als das 1., ein Drittel länger als das 4. Halsschild wenig länger als die halbe Basis, ziemlich gewölbt, sehr dicht mit feinen Nabelpunkten besetzt, allseitig gerandet, Randung der Basis und die Eindrücke normal, Seiten im ersten Viertel kurz gerundet erweitert und dann gleichmässig gerundet verengt, Basisecken breit gerundet. Schildchen dreieckig, Spitze abgerundet. Flügeldecken ziemlich gewölbt, leicht dachförmig, sehr dicht, sehr fein und etwas raspelartig punktiert; Punkte in den Streifen dicht; Zwischenräume ungleich breit, die geraden flach, ungerade gewölbt, Seitenrand im ersten Drittel ziemlich breit; Spitzen, Schultern und Epipleuren normal. Hinterfüsse etwa zwei Drittel so lang wie die Schiene, Metatarsus sehr deutlich länger als die zwei folgenden Glieder zusammen; Analsegment gerade abgestutzt und flach und breit eingedrückt.

LUZON, Benguet, Baguio (*E. Worcester*), 1 Exemplar.

Ich hielt das Tier anfangs für *C. subcostulata* Fairm.; aber diese Art kommt auf den Philippinen nicht vor. Die neue Art ist ihr recht ähnlich, hat aber zwei schwarze Hinterleibsringe

und dunkle Schienen und Füsse. Ihr Halsschildrand ist viel stärker gerundet. Auch *C. alternans* Fairm. gehört in diese Gruppe, hat aber nur ein schwarzes Hinterleibssegment, nur ein helles Fühlergrundglied, und die Basisecken des Halsschildes sind rechtwinklig.

CISTELOMORPHA FESTIVA sp. nov.

Länge 15 mm. Länglich-oval; stark gewölbt, mässig glänzend; sehr fein, kurz, ziemlich dicht gelblich behaart; rötlichgelb, Hinterteil des Kopfes, der Halsschild und die Flügeldecken rot, ungerade Zwischenräume gelb, Fühler bis auf die drei roten Grundglieder und das letzte Hinterleibssegment schwarz, Füsse zuweilen angedunkelt. Kopf normal. Endglied der Kiefertaster an der Spitze gebräunt. Augenabstand zwei Durchmesser. Fühler kaum die Körpermitte erreichend, 3. Glied wenig länger als das 1., ein Drittel länger als das 4. Glied. Halsschild nicht ganz doppelt so breit wie lang, mässig gewölbt, sehr dicht mit starken Augenpunkten besetzt, mit flacher, breiter Mittelfurche, Basis mit gewöhnlicher Buchtung und drei Eindrücken, alle Seiten gerandet, Seiten bis zur Mitte fast gerade, wenig verengt, Apex kürzer als die halbe Basis, Basiswinkel kurz gerundet rechteckig. Schildchen fast gleichseitig dreieckig spitz. Flügeldecken normal, sehr fein und sehr dicht punktiert, hinter dem ersten Viertel an den Seiten breit und flach eingedrückt, helle Zwischenräume bedeutend breiter als die dunkeln; Spitzen und Epipleuren normal. Unterseite gewöhnlich, Prosternalfortsatz dünn, etwas niedriger als die Hüften; letztes Segment vor der Spitze breit, rund und flach eingedrückt, Apex seicht und breit ausgerandet. Beine normal; Hintertarsen so lang wie die Schiene, Metatarsus der Hinterfüsse kaum länger als die zwei folgenden Glieder zusammen.

SÜD-CELEBES, Bonthain (*C. Ribbe, 1882*), und Bantimoeroeng, 6 Exemplare in meiner Sammlung.

Die Art ist nach der Beschreibung der *C. subcostulata* Fairm. sehr ähnlich; aber die neue Art hat an Breite stark verschiedene Zwischenräume der Punktstreifen. Ihr letztes Hinterleibssegment ist an der Spitze ausgerandet, und die Form ihres Halsschildes ist stark abweichend.

CISTELOMORPHA CALIGATA sp. nov.

Länge 9 bis 10.5 mm. Mässig glänzend; fein, ziemlich kurz, fast anliegend, gelblich behaart, die kurzen Borsten im letzten Drittel der Flügeldecken dunkel, mehr abstehend; schwach

bräunlichgelb, Halsschild sehr wenig dunkler, Schienen und Füsse, die zwei letzten Hinterleibssegmente und die Fühler bis auf die zwei Grundglieder schwarz, Spitze der Mandibeln und das letzte Tasterglied angedunkelt. Kopf stark gestreckt, wenig dicht, mittelstark punktiert; Oberlippe flach, schwach quer herzförmig; Clypeus leicht quer, wenig gewölbt, vorn wenig verengt, von der Stirn stark gebogen getrennt; Stirn gewölbt, vorn mit breiter, flacher Mittelrinne; Schläfen sehr kurz; Halsfurche deutlich, Hals längsrissig punktiert; Endglied der Kiefertaster nach vorn sehr deutlich verbreitert, schräge abgestutzt; Fühler kaum halb so lang wie der Körper, schlank, leicht gesägt, 1. Glied dreimal so lang wie breit, 2. ein Drittel so lang, 3. so lang wie das 1. und 2. zusammen, gegen die Spitze breiter, sehr wenig länger als das dreieckige 4., folgende Glieder fast gleich, 11. stark ausgerandet, wenig länger als das 10.; Stirnabstand der Augen fast zwei Durchmesser, beim Männchen weniger. Halsschild gewölbt, doppelt so breit wie lang, sehr dicht, ziemlich fein punktiert, alle Seiten gerandet, in der Basishälfte mit Mittelfurche, Basis neben der Mitte beiderseits ziemlich kräftig, neben den Ecken leicht ausgerandet, Basisecken schwach stumpfwinklig, sehr kurz abgerundet, Seiten bis zur Mitte sehr schwach, wenig gerundet erweitert, dann zum Apex fast gerade schnell verengt, Apex fast gerade, etwas kürzer als die halbe Basis. Schildchen normal. Flügeldecken mit kräftigen, vertieften Punktstreifen, Punkte rund, gegen die Spitze feiner; Zwischenräume etwas gewölbt, fein raspelartig, sehr dicht punktiert, die ungeraden breiter und stärker gewölbt; Epipleuren unvollständig; sehr fein, dicht punktiert; Spitzen normal. Unterseite glänzender, sehr dicht fein punktiert, anliegend, kurz, gelb behaart. Beine normal, Schienen wenig gebogen, gegen die Spitze verbreitert, Spitze der Hinterschenkel erreicht den Hinterrand des 4. Segments (Männchen), Hinterrand des Analsegments gerade, vor dem Rande flach, breit, quer eingedrückt (Männchen); Metatarsus der Hinterfüsse deutlich länger als die zwei folgenden Glieder zusammen.

LUZON, Los Baños (*Baker, 1712, 1717* und *23582*), 4 Exemplare in meiner Sammlung, 3 im United States National Museum.

Die Art ist der *C. distincticornis* Pic recht ähnlich, unterscheidet sich aber durch geringere Grösse. Bei der Pic, schen Art haben die Fühler viel mehr helle Grundglieder; die Schienen sind hell, und die Zwischenräume der Punktstreifen sind gleichmässig gewölbt.

CISTELOMORPHA MIMULA sp. nov.

Länge 10 bis 11 mm. Mässig schlank, gewölbt, sehr fein ziemlich kurz, anliegend, gelb behaart; mässig glänzend; schwach rötlichgelb, die 2 letzten Hinterleibsringe, die Schienen, die Füsse und Fühler bis auf die zwei Wurzelglieder schwarz, die geraden Zwischenräume der Punktstreifen auf den Flügeldecken oft dunkler. Kopf stark gestreckt, nicht sehr dicht und nicht stark punktiert; Oberlippe quer herzförmig, nach der Basis wenig verengt, fast flach; Clypeus schwach quer, gewölbt, wenig verengt; Stirn gewölbt, in der Mitte undicht punktiert; Schläfen äusserst kurz; Halsfurche deutlich; Augenabstand weniger als ein Durchmesser, beim Weibchen etwas mehr; Endglied der Kiefertaster deutlich erweitert, wenig schräge abgestutzt, meist dunkel; Fühler schlank, fast halb so lang wie der Körper, schwach gesägt, 1. Glied ziemlich dünn, viermal so lang wie an der Spitze breit, 2. ein Drittel so lang, 3. etwas gebogen, an der Spitze verdickt, so lang wie das 1. und 2. zusammen, deutlich länger als das 4., dieses lang dreieckig wie die folgenden, diese unter sich fast gleich, 11. normal. Halsschild gewölbt, fast zweimal so breit wie lang, sehr dicht mit mittleren Augenpunkten besetzt, Basis und Apex sehr fein, Seiten scharf gerandet, Halsschild eben vor der Mitte am breitesten, von der Basis an schwach gerundet erweitert, von der Mitte ab schnell gerundet verengt, Basisecken etwas stumpfwinklig, kurz gerundet, Vorderecken verrundet, Apex kürzer als die Hälfte der Basis. Schildchen dreieckig, fein und dicht punktiert, Spitze kurz gerundet. Flügeldecken etwas breiter als die Halsschildbasis, ziemlich gewölbt, nach hinten schwach erweitert, am Ende des 1. Drittels nahe dem Seitenrande sehr schwach, breit und quer eingedrückt; Punktstreifen kräftig, etwas vertief, Punkte rund, nicht sehr dicht, in der Spitze wenig feiner; Zwischenräume dicht, äusserst fein, etwas raspelartig punktiert, fast gleich breit, die ungeraden stärker gewölbt als die ziemlich flachen geraden; Schultern, Spitzen und Epipleuren normal. Schenkel wenig breit, etwas flach, Schienen wenig gebogen; Metatarsus der Hinterfüsse wenig länger als die zwei folgenden Glieder zusammen; Hinterschenkelspitze kaum den Hinterrand des 3. Segments erreichend.

LUZON, Imugan (*G. Böttcher*), 9 Exemplare in meiner Sammlung.

Die Art ähnelt der *C. brevehirsuta* Pic, ist aber bedeutend kleiner, hat dunkle Schienen und ziemlich gleich breite Zwi-

schenräume der Punktstreifen. Der Apex und die Basis des Halsschildes sind viel feiner gerandet.

CISTELOMORPHA ATRICOLLIS Pic.

Länge 10 bis 11 mm. Form gewöhnlich; mässig gewölbt, wenig glänzend; Ober- und Unterseite sehr fein, dicht, ziemlich kurz, anliegend gelblich behaart; schwarzbraun, Kopf mit Ausnahme des Halses, die ersten drei Fühlerglieder, Schildchen und die Beine bräunlichgelb, Flügeldecken gelb, 2., 4. und oft 6. Zwischenraum dunkelbraun, die dunkle Färbung erreicht lange nicht die Basis und die Spitze, Länge der dunklen Streifen von innen nach aussen abnehmend, Mandibelspitzen und Endglied der Taster meist dunkel. Zuweilen sind die Unterseite und der Halsschild heller. Kopf lang, dicht und stark punktiert; Oberlippe fast so lang wie breit, ausgerandet; Clypeus gewölbt, nach vorn etwas verengt, so lang wie breit, Trennungsfurche flach, stark gebogen; Stirn gewölbt; Hals kaum abgeschnürt; Schläfen fast geschwunden; Endglied der Kiefertaster länger als das 3., wenig schräge abgestutzt; Augen normal, Abstand ein Durchmesser oder wenig mehr; Fühler schlank, die Körpermitte überragend, Glieder vom 4. an lang dreieckig, 3. Glied so lang wie 1. und 2. zusammen, länger als das 4., 5. länger als das 4., folgende Glieder nicht verkürzt, Endglied so lang wie das 10., vor der Spitze eingeschnürt, Fühler beim Weibchen kürzer. Halsschild ein Viertel breiter als lang, mässig gewölbt, mit sehr dichten, mässig groben Augenpunkten, Basis jederseits zweibuchtig, vor jeder Ausbuchtung ein flaches Grübchen, Basisecken kurz gerundet rechtwinklig, Seiten erst sehr schwach, von der Mitte ab stärker gerundet verengt, alle Seiten deutlich gerandet, Vorderecken deutlich, breit abgerundet, Apex gerade, halb so lang wie die Basis. Schildchen lang zungenförmig, sehr fein, sehr dicht punktiert. Flügeldecken etwas breiter als der Halsschild, fein und sehr dicht punktiert, grösste Breite am Anfang des letzten Viertels, Schulterbeule kräftig, Spitzen zusammen gerundet, Punktstreifen dicht und kräftig punktiert, etwas vertieft, in der Spitze feiner; Zwischenräume etwas gewölbt, die geraden viel schmäler als die ungeraden; Epipleuren sehr fein, sehr dicht punktiert. Unterseite normal; Beine gewöhnlich, Vorderschienen wenig gebogen, Klauenglied der Vorderfüsse so lang wie die vorhergehenden Glieder zusammen, Tarsen der Hinterfüsse drei Viertel der Schiene; Metatarsus der Hinterfüsse so lang wie die zwei folgenden Glieder zusammen.

LUZON, Imugan, gesammelt von F. Böttcher, 12 Tiere in meiner Sammlung.

Die Art hat grosse Ähnlichkeit mit *C. axillaris* Fairm. var. *nigrolineata* All. von Madura, ist aber kleiner, hat helle Tarsen, drei helle Fühlerwurzelglieder. Die geraden Zwischenräume auf den Flügeldecken sind nicht schwarz und erreichen nicht Spitze und Basis; sie vereinigen sich nicht in der Schulterbeule. Das letzte Segment ist nie allein dunkel.

Cistelomorpha brunneolineata Pic von Manila ist wohl sehr nahe verwandt. Ihre Fühler haben nur zwei helle Grundglieder; Kopf und Halsschild sind rot; ihre Schienen und Tarsen sind dunkel und die zwei letzten Hinterleibsringe schwarz.

CISTELOMORPHA MARTINI Pic.

Länge 9 bis 12 mm. Länglich, stark gewölbt, mässig glänzend, sehr kurz, sehr fein, anliegend, dunkel behaart; schwefelgelb, Schienen und Füsse, die beiden letzten Hinterleibssegmente, die Taster und Fühler mit Ausnahme des Grundgliedes schwarz, Oberlippe gebräunt, Halsschild etwas rötlich, jede Flügeldecke im achten Zwischenraume vom Beginn des zweite Viertels bis zur Mitte mit einem schmalen schwarzbraunen Längsstriche, am Anfang des letzten Drittels vom dritten bis achten Zwischenraume mit einer ziemlich breiten, schräge nach vorn gerichteten Querbinde. Kopf lang, mässig stark und ziemlich dicht punktiert; Oberlippe wenig quer, vorn ausgerandet, Seiten fast parallel; Clypeus fast so lang wie breit, nach vorn etwas gerundet verengt, vorn gerade, von der Stirn durch eine gerade Furche getrennt; Stirn der Länge nach gewölbt; Schläfen sehr kurz; Hals dick, oben sehr schwach abschnürt; Endglied der Kiefertaster lang, schmal, nach vorn wenig erweitert, schräge abgestutzt; Kieferspitzen gebräunt; Fühler die Körpermitte erreichend, kräftig, die einzelnen Glieder lang, verkehrt kegelförmig, 2. Glied doppelt so lang wie breit, 3. etwas gebogen, länger und schmäler als das 4., Glieder vom 4. an stärker gegen die Spitze erweitert, Endglied etwas länger als das 10., an der Aussenseite vor der Spitze flach ausgerandet; Augen gross, ziemlich schmal, stark gewölbt, ausgerandet, Stirnabstand etwas mehr als ein Durchmesser; Halsschild fast doppelt so breit wie lang, wenig gewölbt, sehr dicht mit Augenpunkten besetzt, alle Seiten fein gerandet, Basis dreibuchtig, weil der Mittellappen auch schwach ausgerandet ist, Basisecken rechtwinklig, Seiten in der Basishälfte parallel, dann gerundet verengt, Apex nicht ganz halb so breit wie die Basis, Vorderecken stumpfwinklig ge-

rundet, aber noch erkennbar. Schildchen spitz dreieckig, sehr fein und dicht punktiert und behaart. Flügeldecken breiter als die Halsschildbasis, hinten stark gewölbt, vorn etwas flach, wenig erweitert, sehr dicht, schwach querrunzelig punktiert, mit ziemlich feinen Punktstreifen, Punkte dicht und rund, Zwischenräume etwas gewölbt, nur der 1. und letzte erreichen die Spitze, 3., 5., 7. und 8. Zwischenraum bedeutend breiter als die übrigen, Streifen 3 und 4, der 6. und der 5., der 7. und der 8. vereinigen sich weit vor der Spitze, der 4. und 5., der 7. und 8. verbinden sich nahe der Spitze; Spitzen zusammen abgerundet; Schultern kräftig; Epipleuren vorn breit, äusserst fein punktiert, schwinden vor der Spitze. Unterseite äusserst fein und dicht punktiert, kurz, anliegend, gelb behaart; Beine sehr dicht punktiert und behaart; Schenkel etwas platt; Schienen fast gerade, gegen die Spitze erweitert, mit zwei feinen Enddornen, mit kurzen starren, schwarzen Börstchen, Aussenkante fein gezähnelt; Hinterfüsse zwei Drittel so lang wie die Schienen; Metatarsus viel kürzer als die folgenden Glieder zusammen; Analsegment hinten abgestutzt, beim Männchen vor dem Hinterrande quer flach eingedrückt, Hinterrand schwarz beborstet. Prosternalfortsatz ziemlich schmal, so hoch wie die Hüften.

Viele Exemplare von Buru Station 1:2. bis 6. Dezember 1921, Station 3: 17. bis 23. März 1921, Station 4: 29. bis 31. Januar 1922 und März 1921, Station 13.: 2. bis 3. März 1922. Das Tier lebt auf *Saccharum spontaneum.*

Die Art ist mit *C. trabeata* und *axillaris* Fairm. nahe verwandt, unterscheidet sich aber ausser durch die Färbung durch die verschiedene Halsschildform durch die abweichende Flügeldeckenskulptur.

CISTELOMORPHA ANASTOMOSIS sp. nov.

Länge 11.5 mm. Länglich-oval Flügeldecken im hinteren Teile stark gewölbt; mässig glänzend, halb anliegend, ziemlich dicht, etwas länger, gelblich behaart; gelb, Vorderkörper und drei Grundglieder der Fühler rotbraun, Schienen und Füsse schwarzbraun, zweite Analsegmente glänzend schwarz, Fühler allmählich in Schwarz übergehend. Kopf gestreckt, stark und dicht punktiert; Oberlippe gewölbt, wenig quer, wenig ausgerandet; Clypeus leicht quer, nach vorn verengt, von der Stirn durch einen breiten, tiefen, gebogenen Eindruck getrennt; Stirn ein wenig gewölbt, vorn der Länge nach eingedrückt; Halsfurche breit, deutlich; Schläfen sehr kurz; Taster normal; Augenabstand fast zwei Durchmesser; Fühler kürzer als der halbe Kör-

per, 1. Glied etwas länger als das 4., 3. um die Hälfte länger. Halsschild mässig gewölbt, mit sehr dichten Augenpunkten, halb so lang wie die Basis, Mittelfurche sehr seicht, Basiseindrücke flach, am Anfang des 2. Viertels ein flacher Quereindruck über zwei Drittel der Scheibe, Seiten bis zur Mitte kaum erweitert, dann breit gerundet verengt, Basisecken abgerundet rechtwinklig, Apex flach ausgerandet, nicht halb so breit wie die Basis. Schildchen spitz zungenförmig. Flügeldecken mit starken, etwas dunkleren Punktstreifen, Skulptur gestört, 2. und 3. Zwischenraum im letzten Drittel stark erweitert, stark nach aussen gewendet, Streifen 2 vereinigt sich weit vor der Spitze mit 7, 3 mit 6, Streif 1 erreicht die Spitze, Skulptur im letzten Fünftel gänzlich gestört, Streifen 4 und 5 enden frei; Zwischenräume ziemlich stark gewölbt, stark ungleich breit, ziemlich dicht und fein, etwas raspelartig punktiert. Unterseite sehr dicht punktiert und behaart; Prosternalfortsatz etwas höher als die Hüften; Hintertarsen drei Viertel der Schiene; Metatarsus der Hinterfüsse fast um die Hälfte länger als die zwei folgenden Glieder zusammen; Analsegment an der Spitze breit gerundet.

OST-BALI, Kintamani (*E. Stresemann*), 2 Exemplare im Museum Dresden und in meiner Sammlung.

Die Art weicht von allen mir bekannten Arten durch die eigenartige Flügeldeckenskulptur weit ab.

Genus CISTELODEMA novum

Die neue Gattung ist sehr nahe mit *Ectenostoma* Fåhr. verwandt; aber ihr Kopf ist nicht stark verlängert, und der Halsschild ist vorn deutlich abgestutzt. Mandibeln einspitzig, Endglied der Kiefertaster messerförmig. Fühler vom 4. Gliede an erweitert und stark abgeplattet; Augen gross, Abstand mindestens halber Durchmesser. Halsschild gewölbt, quer, Vorderecken nicht ganz verrundet, Apex gerade abgestutzt oder flach bogenförmig ausgerandet, alle Seiten gerandet, mit scharfen Kanten, Basis in der Mitte vorgezogen. Schildchen breit dreieckig. Flügeldecken am Grunde kaum breiter als die Halsschildbasis, mit feinen, kaum vertieften Punktstreifen, Zwischenräume flach, Epipleuren fast die Spitze erreichend. Beine verhältnismässig kurz, Hinterschenkelspitze den Hinterrand des 3. Segmentes kaum überragend, Vordertarsen schmal. Die Type der Gattung ist *Pseudocistela cyanea* Pic.[3] In die Gattung ge-

[3] Mél. exot.-ent. 55 (1930) 29.

hören ausser der genannten Art *C. bruneiensis* Pic, *C. metallica* Pic, und die Varietät *uniformis* Pic.

Bestimmungstabelle.

1 (4) Flügeldecken mit feinen, aber deutlichen Punktstreifen.

2 (3) Oberseite metallisch blau, der 2. Punktstreifen im letzten Drittel schwach, aber deutlich eingedrückt. Länglich, glänzend, oben blau oder grün; Schildchen in der Mitte schwach gefurcht; Fühler ziemlich kurz, mittlere Glieder stark erweitert. Länge 5 bis 6 mm. Mindanao. (Originalbeschreibung in Übersetzung.) *C. cyanea* Pic.

3 (2) Oberseite grün, zum Teil rötlich; 2. Streifen in der Spitze nicht erkennbar eingedrückt. Länge 5 mm. Schwarz metallisch. Brust und Oberseite metallisch grün, Fühler kurz, Glied 5 und folgende stark erweitert, Scutellarstreif fast geschwunden. Borneo. (Nach Beschreibung.) .... *C. bruneiensis* Pic.

4 (1) Flügeldecken mit kaum erkennbaren Punktstreifen.

5 (6) Rötlich, Oberseite metallisch, Halsschild blau. Länge 5.5 mm. Länglich-suboval, glänzend, rötlich, oben metallisch, Kopf hinten und die Flügeldecken rot, teilweise grünlich schimmernd, Halsschild blau; Fühler kräftig, Halsschild fein und sparsam punktiert, Flügeldecken wenig deutlich, fein gestreift, Zwischenräume mit vielen feinen Punkten. Borneo........ *C. metallica* Pic.

6 (5) Käfer einfarbig, Flügeldecken ein wenig irisierend. var. *uniformis* Pic.

ERSTER NACHTRAG ZU DIE LAGRIIDEN-FAUNA DER PHILIPPINEN

Von FRITZ BORCHMANN
Hamburg, Deutschland

Erst nach dem Erscheinen meiner Arbeit in dieser Zeitschrift[1] kam mir das schöne Material zu Gesicht, das Herr W. Schultze in Bad Tölz auf den Philippinen gesammelt hat. Die Sammlung enthält eine Anzahl für die Fauna höchst charakteristischer Arten, die in meiner Abhandlung fehlen. Darum erweist sich ihre Beschreibung und Veröffentlichung als durchaus notwendig. Die Einreihung in die Tabellen ist ohne besondere Schwierigkeiten wie folgt vorzunehmen.

Lagria schultzei und *L. patricia* müssen auf Seite 406 unter b^{2} eingefügt werden:

b^{2}. Jede Flügeldecke mit zwei Reihen sehr breiter Gruben.
1 (6) Die Gruben sind sehr deutlich und stark.
2 (5) Die Zwischenräume der Punkte auf den Flügeldecken sind ohne von den Punkten ausstrahlende sternförmige Linien.
3 (4) Zwischenräume stark glänzend, Punkte der Flügeldecken feiner und flacher, u. s. w. .... *L. foveata* Bm.
4 (3) Zwischenräume weniger glänzend, Punkte gröber und tiefer, u. s. w. .... *L. meloides* Bm.
5 (2) Zwischenräume mit sternförmig von den Punkten ausstrahlenden Linien, Gruben schwächer, u. s. w. Siehe folgende Beschreibung! .... *L. schultzei* sp. nov.
6 (1) Gruben sind nur angedeutet; Zwischenräume sehr dicht punktiert, matt, u. s. w. .... *L. patricia* sp. nov.

SIEHE BESCHREIBUNG

Helogria clavipes sp. nov., lässt sich nach der Beschreibung hinter *H. pilosa* Bm. auf Seite 426 leicht einordnen.

Leider war es mir der grossen Entfernung wegen nicht möglich, die Korrektur meiner Arbeit selbst zu lesen. So sind trotz der ausserordentlichen Sorgfalt, die der Herr Chief Editor auf meine Veröffentlichung verwendet hat, dennoch eine allerdings

[1] Philip. Journ. Sci. 41 (1930) 403.

sehr geringe Anzahl von Druckfehlern entstanden, deren sinnstörende ich hier verbessern möchte.

Seite 405 unter *d*[2] der Gattungstabelle muss es heissen: . . . Mittelglieder *zuweilen* deformiert.

Seite 411 Zeile 6 von unten: Sie ist erheblich mässiger *gewölbt* und weniger glänzend.

Seite 430 Zeile 7 von unten muss "Untergattung Lagriodes" gestrichen werden.

Seite 441 letzte Zeile muss eingefügt werden . . . *Splichalia* Reitt. und auf.

Seite 442 gestrichen werden.

Seite 475 *h*[2] Die Beschreibung von *S. tenera* Bm. von "Blau, Hals u. s. w. muss hier gestrichen und Seite 476 hinter *S. palawana* eingefügt werden.

Seite 477 Zeile 8 von oben, letztes Wort darf nicht heissen "Becken," sondern muss lauten: "Flügeldecken."

Seite 529 letzte Reihe der "Übersicht etc." muss statt *v. atriceps* Pic "*v. lineata*" Pic heissen.

BESCHREIBUNGEN

LAGRIA SCHULTZEI sp. nov.

Länge 24 mm. Mässig gestreckt, gewölbt, Flügeldecken nach hinten deutlich erweitert; schwarz mit blaugrünem Scheine, Beine an der Basis blau, im Übrigen grün metallisch, Fühler dunkel schwarzblau, Kopf schwarz mit rotviolettem und grünlichem Erzglanz, Halsschild an den Rändern grün metallisch, in der Mitte rotkupfrig und blau, Schildchen grünlich und kupferig, Flügeldecken trüb rotviolett, Flügeldecken kurz, fein, fast anliegend, schwarz behaart; mässig glänzend, Flügeldecken fast matt. Kopf gewöhnlich, dicht und grob punktiert; Oberlippe quer, feiner punktiert, nicht ausgerandet; Clypeus mehr als doppelt so breit wie lang, mässig ausgerandet, Vorderecken gerundet, von der Stirn durch eine scharfe, nach vorn offene, gebogene Furche getrennt; Stirn mit hufeisenförmiger, glatter Stelle; Schläfen allmählich gerundet verengt, ein und ein halb mal so lang wie ein Auge; Hals wenig abgeschnürt; Mundteile gewöhnlich; Fühler fadenförmig, die Schultern überragend, mässig dick, 1. Glied etwas geschwollen, 2. halb so lang, 3. über drei mal so lang wie das 2., nach der Spitze zu etwas erweitert, etwas länger als das 4., folgende wenig kürzer, 11. etwas länger als das 10., etwas dünner, zugespitzt, die ersten 5 Glieder glänzend; Augen schmal, stark ausgerandet, Stirnabstand mehr als

ein Durchmesser. Halsschild leicht quer, breiter als der Kopf mit den Augen, gewölbt, uneben, ziemlich dicht mit groben Augenpunkten besetzt, mit breiter, flacher Mittelfurche und jederseits mit einem flachen Eindruck, der schräge von der Mitte aussen nach der Basismitte läuft, Skulptur der Mittelfurche etwas gestört, Seiten nach vorn wenig gerundet erweitert, grösste Breite nahe dem Vorderrande, Vorderecken leicht abgerundet, Basisecken vorstehend, Apex deutlich, Basis stark und breit, Seiten in der zweiten Hälfte scharf gerandet. Schildchen zungenförmig, stark und dicht punktiert. Flügeldecken fast doppelt so breit wie die Halsschildbasis, gewölbt, sehr dicht, mässig stark punktiert, Zwischenräume der Punkte fein sternförmig gerunzelt, Runzeln strahlen von dem Punkte aus, an der Naht im erste Drittel mit je zwei hinter einander liegenden ziemlich flachen, am Seitenrand je vier flachen Gruben in den ersten vier Fünftel; Epipleuren breit, allmählich verengt, vollständig, gröber punktiert und ziemlich stark querrunzelig; Spitzen zusammen abgerundet. Unterseite normal; Beine gewöhnlich; Metatarsus der Hinterfüsse kaum länger als die zwei folgenden Glieder zusammen.

MINDANAO, Bukidnon, Lindabon (*W. Schultze*), 2 Weibchen, davon 1 Exemplar in meiner Sammlung.

Die Art hat grosse Ähnlichkeit mit *L. meloides* Bm.; aber die Flügeldecken der neuen Art sind wegen der eigenartigen Grundskulptur fast matt; die Flügeldeckengruben sind bedeutend flacher, und die Färbung weicht stark ab. Ich benenne die Art nach ihrem Entdecker, Herrn W. Schultze in Bad Tölz.

LAGRIA PATRICIA sp. nov.

Länge 18 mm. Form gewöhnlich; pechschwarz mit grunlichem Metallschimmer, Vorderbrust mit trüb kupfrigen Reflexen, Beine an der Basis pechschwarz mit leicht rötlichem Scheine, 2. Schenkelhälfte und Schienen goldgrün, Schienenspitze wie die Schenkelbasis, Vorderkörper kupferrot, Oberlippe schwarz, Vorderrand des Clypeus und die Ränder des Halsschildes goldgrün, Flügeldecken glanzlos, dunkel kupfrigviolett, Fühler schwarz mit schwach bläulichem Scheine; Oberseite hell behaart, Vorderkörper länger und spärlicher, Flügeldecken ziemlich dicht, kürzer, Unterseite länger, anliegend. Kopf dicht und stark punktiert; Oberlippe normal, feiner punktiert; Clypeus gewöhnlich, von der Stirn durch eine scharfe, fast gerade Furche abgesetzt; Stirn uneben, mit je einem ziemlich tiefen Längseindruck neben den Augen, in der Mitte der gewölbten

Stirn ein flaches Grübchen; Schläfen abgerundet eckig, etwas länger als ein Auge von oben gesehen; Hals deutlich abgeschnürt; Mundteile normal; Fühler dünn, fast fadenförmig, die Körpermitte nicht ganz erreichend, 1. Glied geschwollen, etwas länger als breit, 2. halb so lang, 3. und 4. fast gleich, an der Spitze etwas knotig verdickt, folgende etwas kürzer, 11. etwas dünner, gebogen, zugespitzt, etwas länger als das 10.; Augen normal, Stirnabstand ein und ein Viertel Durchmesser. Halsschild fast so lang wie breit, breiter als der Kopf mit den Augen, mit groben Augenpunkten sehr dicht besetzt, sehr uneben, mit flacher Mittelfurche, auf der Scheibe jederseits zwei ziemlich tiefe und breite Gruben, die vordere weiter nach innen, in der Basis eine 5. flachere Grube, Seiten in der zweiten Hälfte stark gerandet, von der Basis bis zur Mitte wenig, dann plötzlich stark bogenförmig erweitert, eben vor dem Vorderrande am breitesten, Apex ein Fünftel breiter als die Basis, Vorderecken kurz verrundet, Basiswinkel vorstehend, Vorderrand stark, in der Mitte undeutlich, Basis stark gerandet, Behaarung nach der Mitte gekämmt. Schildchen zungenförmig, dicht und feiner punktiert und behaart. Flügeldecken gewölbt, nach hinten etwas erweitert, fast doppelt so breit wie die Halsschildbasis, dicht und ziemlich fein punktiert, die schmalen Zwischenräume der Punkte sehr dicht und sehr fein querrunzelig, jede Decke nahe dem Rande mit drei sehr breiten und sehr flachen hinter einander liegenden Eindrücken; Schultern stark; Spitzen zusammen gerundet; Epipleuren vorn sehr breit, allmählich verengt, vollständig, skulptiert wie die Decken. Unterseite normal; Beine ziemlich dünn, Schenkel sehr wenig keulig, Hinterschenkelspitze den Hinterrand des 3. Segments wenig überragend; Metatarsus der Hinterfüsse so lang wie die drei folgenden Glieder zusammen.

MINDANAO, Bukidnon, Lindabon (*W. Schultze*), 1 Weibchen in meiner Sammlung.

Die Art ist mit *L. meloides* Bm. und *schultzei* m. verwandt, ist aber kleiner. Die Gruben der Flügeldecken sind nur angedeutet; der Halsschild trägt 4 scharfe Gruben, und die Färbung ist ganz abweichend.

LAGRIA RUGOSICOLLIS sp. nov.

Länge 13 mm. Stark gewölbt, Flügeldecken fast bauchig; mässig glänzend; fein, undicht, kurz, bräunlich behaart; pechschwarz mit stahlblauem glanze, Beine bis auf die Schenkel-

basis dunkelviolett, Kopf dunkelblau mit grünen Reflexen, Halsschild dunkel metallgrün, Fühler wie die Unterseite gefärbt, Flügeldecken lebhaft violett mit grünlichen Reflexen. Kopf normal, mit sehr dichten, groben Augenpunkten, Oberlippe gewöhnlich, feiner punktiert; Clypeus von der Stirn durch eine sehr feine, fast gerade Linie abgesetzt; Stirn gewölbt, etwas uneben; Schläfen wenig verengt, abgerundet, dreimal so lang wie ein Auge; Hals dick, deutlich abgeschnürt; Mundteile normal; Augen schmal; Fühler ziemlich dünn, fast fadenförmig, 1. Glied geschwollen, doppelt so breit wie lang, 2. so lang wie breit, sehr kurz, 3. etwas länger als das 4., an der Spitze etwas verdickt, die folgenden Glieder etwas kürzer, unter sich gleich, 11. leicht gebogen, zugespitzt, etwas kürzer als das 10. Halsschild leicht quer, ein Viertel breiter als der Kopf mit den Augen, gewölbt, sehr dicht mit groben Augenpunkten besetzt, Zwischenräume runzlig, Mittelfurche flach und breit, Skulptur hier gestört, Seiten wenig gerundet, fast parallel, in der zweiten Hälfte fein gerandet, Apex undeutlich, Basis fein gerandet, Vorderecken kurz verrundet, Basiswinkel wenig vorstehend. Schildchen breit dreieckig mit abgerundeter Spitze, dicht punktiert, metallgrün. Flügeldecken doppelt so breit wie die Halsschildbasis, mit starken Schultern, sehr dicht und ziemlich fein punktiert, kaum gerunzelt, hinter dem Schildchen sehr schwach flachgedrückt; Spitzen zusammen abgerundet, Epipleuren vorn sehr breit, vollständig, gröber punktiert als die Decken, etwas querrunzelig. Unterseite fein und ziemlich dicht punktiert, anliegend, nicht sehr dicht behaart; Beine ziemlich dünn, Schenkel wenig keulig, Hinterschenkelspitze den Hinterrand des 3. Segments nicht erreichend, Schienen fast gerade; Metatarsus der Hinterfüsse leicht gebogen, fast so lang wie die folgenden Glieder zusammen.

MINDORO, Mount Calavite (*W. Schultze*), 1 Weibchen in der Sammlung W. Schultze.

Die Art erinnert lebhaft an manche *Chrysolagria*-Arten. Von den Philippinen kenne ich keine nahe verwandte Art. *L. bryanti* m. ist kleiner, weniger gewölbt, ziemlich einfarbig rotbraun und hat viel weniger stark punktierten Halsschild.

HELOGRIA CLAVIPES sp. nov.

Länge 10.5 bis 11 mm. Form gewöhnlich, mässig, glänzend, von gewöhnlicher Wölbung; ziemlich dicht, mittellang, fast anliegend weisslich behaart; dunkel rotbraun, zweite Schenkel-

hälfte, Schienen und Tarsen, Fühler und Halsschild pechschwarz, Flügeldecken mit sehr schwachem Metallschimmer. Kopf kurz, grob, nicht sehr dicht punktiert; Oberlippe stark quer, feiner punktiert, vorn ausgerandet; Clypeus mehr als doppelt so breit wie lang, nach vorn verengt, breit ausgerandet, von der Stirn durch einen tiefen, vorn offenen Bogen getrennt; Stirn in der Mitte leicht vertieft, zwei Drittel Augenbreite; Schläfen kürzer als ein Auge, allmählich gerundet verengt; Hals gewöhnlich; Mundteile normal; Fühler die Schultern wenig überragend, ziemlich dünn, nach aussen kaum verdickt, sehr schwach gesägt, fein behaart, zwei Grundglieder glänzend, 1. Glied etwas geschwollen, 2. ein Drittel so lang, 3. und 4. gestreckt, gleich lang, die folgenden Glieder wenig kürzer, 11. leicht gebogen, etwas zugespitzt, fast so lang wie die drei vorhergehenden Glieder zusammen; Augen gross, stark gewölbt. Halsschild ein Viertel länger als an der Basis breit, schwach glockenförmig, etwas breiter als der Kopf mit den Augen, ziemlich dicht und stark punktiert, leicht querrunzelig, grundbehaarung nach der Mitte gelagert, dazwischen lange, aufrechte dunkel Borsten, Scheibe von der Mitte der Seite nach der Basismitte schräge eingedrückt, Apex in der Mitte ungerandet, Basis aufgebogen, Vorderecken verrundet, Basisecken sehr wenig vorstehend. Schildchen zungenförmig, sehr dicht und fein punktiert. Flügeldecken mit starken Schultern, doppelt so breit wie die Halsschildbasis, nach hinten etwas erweitert, dicht, stark und leicht querrunzelig punktiert; Epipleuren vorn breit, bis zur Spitze allmählich verengt, skulptiert wie die Decken; Unterseite fein und dicht punktiert und fein behaart, Seiten des Abdomens uneben. Beine halb anliegend, lang behaart; Schenkel keulig, Schienen wenig gebogen, Hinterschienen innen am Ende des ersten Drittels mit einem kurzen, spitzen Zahn, die letzten zwei Drittel leicht ausgeschnitten, die Hinterschenkelspitze überragt den Hinterrand des 3. Segment nur wenig.

MINDANAO, Bukidnon, Lindabon (*W. Schultze*), 2 Männchen, davon 1 Tier in meiner Sammlung.

Die Art ist der *H. pilosa* m. ähnlich; aber diese ist viel heller, hat viel kürzeren Halsschild, ihre Behaarung ist viel dichter, und ihre Schenkel sind nicht keulig.

THE JAPANESE BEAM TRAWL USED IN PHILIPPINE WATERS

By Agustin F. Umali

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FIVE PLATES AND NINE TEXT FIGURES

INTRODUCTION

The evolution of the "utase" method of fishing from the original sailing sampans towing five to seven small-sized nets, as described by Montalban and Martin,[1] to the present power-propelled vessels towing but one large trawl, is here deemed worthy of detailed discussion.

As early as the year 1900, there were a limited number of these sailing sampans operating in the open waters of Manila Bay. Gradually they have increased in number and since 1928 have largely substituted engines for sails as motive power. At the time of writing, they number seventy power-propelled sampans and these have extended their operations as far as Lingayen and Ragay Gulfs and Negros.

With the exception of two boats under Filipino ownership (Mr. Tomas Lichauco), these beam trawlers, which compose the fleet, are all owned by Japanese; one person owning from one to four vessels. The owners of these boats do no actual fishing but employ operating crews. They have formed a union known as the "Tondo Fishermen's Union" headed by a prominent Japanese.

THE FISHERMEN

The fishermen employed by the Japanese beam trawlers are all Japanese who are graduates of or have taken courses in some fishery school in Japan. They receive a definite salary from the owner of the boat. Those who have been in the employ of the owner for a considerable length of time do not receive a time-wage but a piece-wage in the form of a share in the profits.

[1] Philip. Journ. Sci. 42 (1930) 465–480.

In addition to the regular Japanese fishing crew, Filipino laborers are hired as *cargadores*, boatmen or *banqueros*, tanners, and caretakers of the nets when they are being dried, tanned, or repaired.

A Japanese beam trawler is generally manned by four or five men. The captain is in command of navigating the vessel and also directs and controls the entire fishing operation. The mechanic is another member of the crew, whose business it is to run the engine during navigation and to help in the shooting and hauling, or heaving up, of the trawl. The other two or three members of the crew are fishermen. They shoulder the burden of the actual fishing operations, such as preparing the net for shooting, shooting, and hauling of the net. In addition to these activities, they take care of the catch, clean the deck, cook the food, mend the net, prepare the lights and signals in the evening, and hoist the net to the masts for drying after the day's fishing is over.

THE VESSELS

The vessels used are all Japanese made and are designed and constructed by Japanese shipbuilders in Manila purposely for trawling.

A typical Japanese beam trawler (Plate 2, fig. 3), is a two-masted wooden sampan, which measures from 41 to 61 feet in length, with a beam of from 8 to 13 feet and a depth of from 2.05 to 5 feet and is equipped with a crude-oil engine of from 20 to 70 horsepower and an auxiliary sail, which is especially useful in the fishing operation. As shown in the registry records in the Bureau of Customs (see Table 1), they range in size from 7.73 to 20.89 gross tons.

From the foremast, the deck is clear aft to the engine room. The motor-driven winch, which is provided with iron rollers, is mounted above the engine room. Behind the engine room are the wheelhouse and a low cabin which runs aft in the center of the vessel, leaving a clear passage on both sides and enough space of clear deck at the stern to permit work and coiling of the trawl warps. Text fig. 1 shows the deck plan of a typical Japanese trawler.

A variation from the typical trawler is found in some of the more-antiquated vessels, which were originally sailing sampans but were later converted into powered vessels. These have no

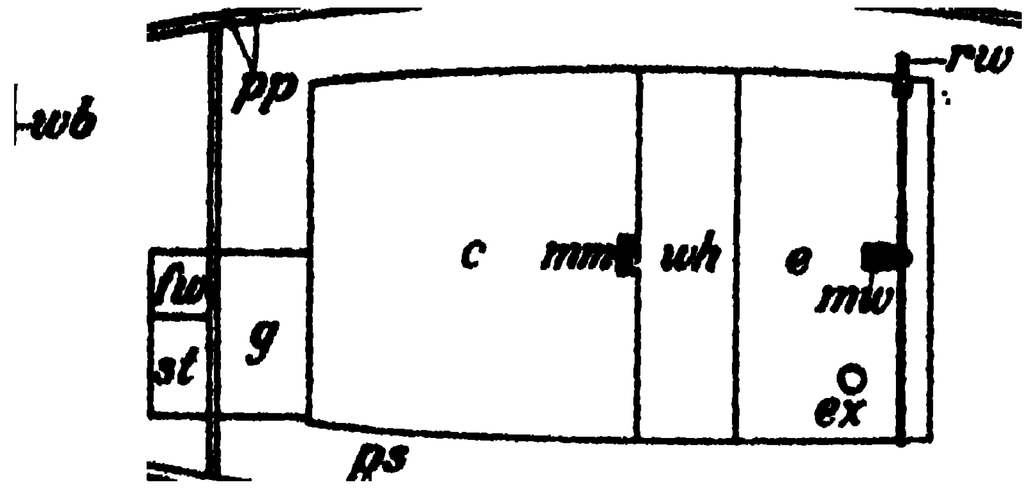

FIG. 1. A typical Japanese beam trawler, deck plan; *b*, bowsprit; *c*, cabin; *e*, engine room; *ex*, exhaust; *fm*, foremast; *fw*, fresh-water tank; *g*, galley; *h*, hatch cover; *mm*, mainmast; *mw*, motor winch; *pp*, wooden pins on the port side; *ps*, wooden pins on the starboard sides; *rb*, roller toward bow; *rw*, roller of winch; *sd*, small derrick; *st*, store box for provisions; *wb*, wooden bar; *wh*, wheelhouse.

wheelhouse, but instead are provided with a detachable wooden rudder, which is manipulated directly by means of the tiller.

Table 1 shows the tonnage and dimensions of the beam-trawlers registered in the Bureau of Customs up to 1931.

THE FISHING APPARATUS

The Japanese beam trawl is in the form of a more or less conical bag provided with two long wings of equal length. The wings are separated from each other by a long wooden beam and are held upright by a brail attached to the ends of each. The under portion of the whole arrangement drags on the bottom as the net is towed. As has previously been stated, the trawls used in these power-propelled vessels are of exactly the same construction as those towed by the original sailing sampans, although they are now much larger affairs, with proportionately longer wings.

Text figs. 2 to 5 show the different parts of a typical Japanese beam trawl. The dimensions of the various parts of the trawl together with the data on the size of the cotton twine and the widths of the mesh are shown in fig. 4. Variations from these measurements will be observed in different nets, although the figures noted are typical.

The various parts of a typical Japanese beam trawl could be grouped under four main divisions; namely, the trawl warps and bridles, the beam, the brail, and the trawl net.

The trawl warps and bridles.—The trawl warps, or ropes, which are employed in towing the trawl net are all of abacá (*Musa textilis* Née, Manila hemp). The main towline is a 1.5-

TABLE 1.—*Beam-trawlers registered in the Bureau of Customs up to 1931.*

[The port of operation changes from time to time.]

Name of boat.	Gross tonnage.	Net tonnage.	Length.	Breadth.	Depth.	Power.	Men in crew.	Port of operation.
			m.	*m.*	*m.*	*h. p.*		
Ambassador	14.86	7.20	17.00	3.68	1.40	70	5	Lingayen Gulf.
Asahi Maru	11.20	7.62	15.24	3.54	0.98	40	4	Ragay Gulf.
Bingo Maru	14.34	8.75	18.00	3 65	1.08	25	5	Lingayen Gulf.
Caycoku Maru	9.88	6.72	15.66	3 71	1.31	28	4	Ragay Gulf.
Cherry Blosom	11.94	8.13	19 12	3.38	0.89	60	4	Manila Bay.
Chiokiu Maru	12 95	8.81	16.00	3 30	1.00	40	4	Lingayen Gulf.
Chowa Maru	13.40	9.11	14.50	3 28	1.20	25–28	5	Do.
Chukai Maru	11.72	7.96	16.70	3.10	1 10	25	5	Bacolod, Occ. Negros.
Daikoko Maru	8.92	6 07	16 30	3 23	0 80	40	4	Ragay Gulf.
Ebesu Maru	12 39	8.43	14 85	3 15	1 25	20	4	Manila Bay.
Ebi Maru	13.39	6.95	16.90	3 70	1.28	40	5	Do.
Ekyu Maru	19 27	8 97	17.90	3.37	1.35	40	4	Lingayen Gulf.
Fujikawa Maru	11.56	7.87	15 90	3 50	0.98	30	4	Manila Bay.
Fukue Maru	14 50	6.85	18 60	3.36	1.25	40	4	Ragay Gulf.
Fukushima Maru	11 95	8 13	17.34	3 46	0.94	40	4	Manila Bay.
Guigatuco Maru	12 16	8 27	16.54	3.47	1.00	20	4	Ragay Gulf.
Go Go	14.46	8.45	17.00	3.85	1 43	40	5	Do.
Hachiman Maru	14.02	9 54	16.75	3 37	1.15	40	4	Guinayañgan.
Hatae Maru	14.77	10.26	17.05	3 85	1.22	40	4	Lingayen Gulf.
Hayatomo Maru	11.99	8.15	14.95	3 35	1 00	40	4	Manila Bay.
Imperial [a]	10.56	7.18	18.19	3.75	1 26	....	5	Lingayen Gulf.
Jiyu Maru	9 11	6.20	13.20	3.10	1.05	20	4	Guinayañgan.
Juku Maru	14 98	10.19	17.62	3 34	1.20	25	4	Manila Bay.
Kaiyo Maru	20.89	14.21	17.00	3 45	0 44	20–25	4	Do.
Kanichi Maru	8 45	5.75	16 68	2 67	0.80	40	5	Do.
Kasuga Maru	7.73	5 28	15 20	3 00	0 80	28	4	Do.

Kinokuni Maru	12.42	8.48	14.50	3.30	1.10	20	4	Lingayen Gulf.
Kinsei Maru	12.02	6.92	14.45	3.85	1.05	30	4	Manila Bay.
Kioday Maru	14.40	9.80	17.08	3.65	1.00	25	5	Do.
Kochi Maru	10.67	7.26	14.50	2.76	1.20	25–30	4	Do.
Kofuko Maru	14.32	9.74	17.25	3.94	0.98	25–30	4	Guinayañgan.
Konpira Maru	14.52	9.87	18.22	3.74	1.06	20	4	Lingayen Gulf.
K. O.	12.32	8.38	12.55	3.00	1.22	12	4	Aloneros.
Koshindo Maru	14.93	10.06	15.10	3.25	1.27	40	4	Manila Bay.
Kotoku	14.92	10.15	17.80	3.38	1.35	50	4	Guinayañgan.
Koun Maru	17.43	11.86	17.43	4.06	1.59	60	4	Manila Bay.
Koye Maru	15.61	10.62	18.15	3.68	1.10	35	4	Do.
Kyosin Maru	13.78	9.03	16.80	3.39	1.10	25	4	Do.
Liyoe Maru	11.56	7.87	17.40	3.80	0.95	40	4	Do.
Liyoun Maru [a]	12.15	8.27	16.80	3.25	1.05	40		Guinayañgan.
Lyose Maru	10.81	7.35	14.50	3.00	1.20	30	6	Lingayen Gulf.
Manila Maru	14.14	14.14	17.60	3.68	1.03	20	5	Do.
Manyoshi Maru	15.49	10.48	14.65	3.78	1.82	40	4	Manila Bay.
Mary	9.90	6.78	14.98	3.12	1.00	25–28	4	Lingayen Gulf.
Miyoshi Maru	13.85	9.42	13.95	3.70	1.10	25–28	4	Manila Bay.
Mayon I	14.47	10.16	18.80	3.37	1.10	20–40	5	Do.
Miojin Maru	12.59	8.57	16.50	3.60	1.00	40	5	Guinayañgan.
Momoshima Maru	10.25	6.97	16.07	3.67	0.82	40	4	Do.
Nagaaki Maru	14.13	9.61	17.18	3.87	1.86	60	4	Lingayen Gulf.
Nagasawa Maru [a]	12.48	12.48	13.90	3.39	1.25		5	Do.
Nagayoshi Maru	9.40	6.40	15.35	3.75	0.80	20	4	Lingayen Gulf.
Nagayoshi Maru II	13.66	9.19	17.20	3.60	1.10	40	5	Do.
Nikkai Maru	17.78	8.55	17.05	3.81	1.43	40	5	Manila Bay.
Nishiki Maru	8.08	5.49	18.60	3.30	0.85	25–28	4	Aloneros.
Ondo Maru	13.69	9.31	14.00	3.57	1.00	25–28	4	Manila Bay.
Rosy	12.11	8.24	17.50	3.35	0.92	40	5	Ragay Gulf.
Ryoho Maru	14.58	9.92	18.00	3.90	0.98	40	4	Manila Bay.
Ryojuku Maru	11.56	7.26	16.88	3.60	0.90	40	5	Do.
Sakai Maru	10.48	7.13	14.27	3.45	0.78	40	4	Do.

[a] Vessels with incomplete records in the Bureau of Customs.

TABLE 1.—*Beam-trawlers registered in the Bureau of Customs up to 1931*—Continued.

Name of boat.	Gross tonnage.	Net tonnage.	Lenght.	Breath.	Depth.	Power.	Men in crew.	Port of operation.
			m.	*m.*	*m.*	*h. p.*		
Saiway Maru	12.18	8.29	17.50	3.65	0.90	25–28	4	Lingayen Gulf.
Sata Maru	11.28	7.67	16.90	3.50	0.90	28	4	Manila Bay.
I. Shiwaka Maru	9.88	6.72	17.20	3.70	0.96	60	4	Do.
Show Boat	12.29	8.36	17.70	3.47	1.60	50	6	Lingayen Gulf.
Showa Maru	12.47	8.48	17.80	3.80	0.87	25–28	4	Ragay Gulf.
Sindiki Maru	9.69	6.59	15.77	3.37	0.86	40	4	Manila Bay.
Swou Maru	12.19	8.29	17.18	3.46	0.93	30	4	Do.
Toke Maru	10.39	7.01	14.60	3.33	1.00	40	4	Guinayangan.
Toki Maru [a]	10.29	7.00	15.69	3.40	0.91			Do.
Tokiyoshi Maru	14.94	10.26	18.30	3.74	1.03	25–28	4	Ragay Gulf.
Yamato Maru	14.20	9.66	17.10	3.50	1.00	28	6	Do.

[a] Vessels with incomplete records in the Bureau of Customs.

to 1.75-inch rope[1] and measures from about 500 to 750 feet long. In operation, one end is attached by means of a wooden pin to the towing tackle, which is an arrangement of ropes and

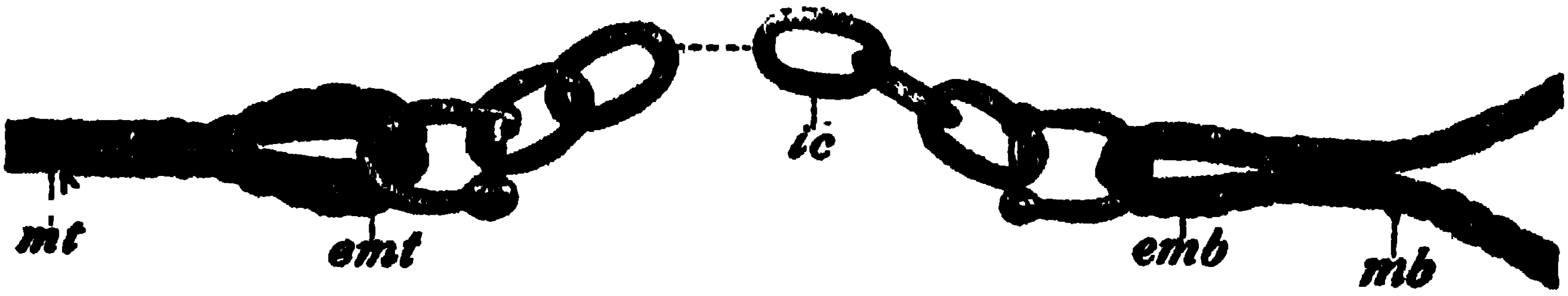

FIG. 2. A portion of the trawl warp, showing connection of main towline, iron chain, and main bridle; *emb*, eye-splice and thimble of main bridle; *emt*, eye-splice and thimble of main towline; *ic*, iron chain; *mb*, main bridle; *mt*, main towline.

pulleys on the gunwale of the stern of the boat that keeps the pull on the net almost in line with the long axis of the vessel. The opposite end of the main towline is provided with an eye-splice and thimble (fig. 2, *emt*), to which is shackled an iron chain about 25 feet in length and weighing about 190 pounds. The other end of this iron chain is again shackled to the eye-splice and thimble of the bight of the main bridle (fig. 2, *emb*). Each of the warps of the main bridle is a 1- to 1.5-inch rope and measures about 200 feet long. The free ends of each of the warps of the main bridle offer attachment to from one to three sets of iron-chain weights, to the ends of the beam, and to a 25-pound disk-shaped stone weight. The set or sets of iron-chain weights which serve to sink the beam and the net have

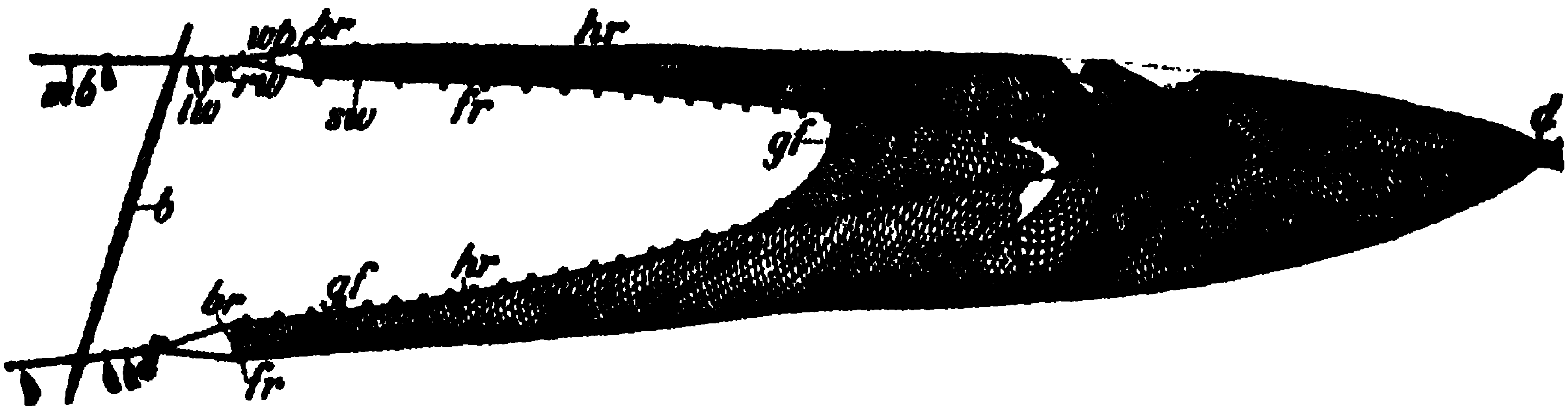

FIG. 3. Perspective view of the gear, showing important parts; *b*, beam; *bl*, belly; *br*, brail; *bt*, bating; *c*, cod end, or bag; *d*, draw string, or poke line; *f*, funnel-like affair; *fr*, foot rope; *gf*, glass floats; *hr*, head rope; *iw*, iron-chain weights; *mb*, main bridle; *rw*, rock weight; *s*, square; *sw*, stone weights; *w*, wing; *wb*, wing bridle.

an aggregate weight of from 165 to 220 pounds. To the ends of each of the warps of the main bridle is tied the bight of the wing bridle. The wing bridle is formed from a 16-foot prolongation of the foot rope (the weighted rope attached to the lower edge of the trawl net for the purpose of holding the lower part

[1] These measurements of the warps are the diameters.

of the net on the bottom), the end of which (foot rope) is tied to the end of the head rope (the rope on the trawl net upon which floats are attached for the purpose of holding the top part of the net). The upper warp of the wing bridle, which offers attachment for the upper end of the brail, may be considered a continuation of the head rope, and the lower warp, to which is attached the lower end of the brail, a prolongation of the foot rope. The wing bridles (figs. 3 and 5), which thus help in keeping the wings of the trawl net in an upright position, are 8 feet long.

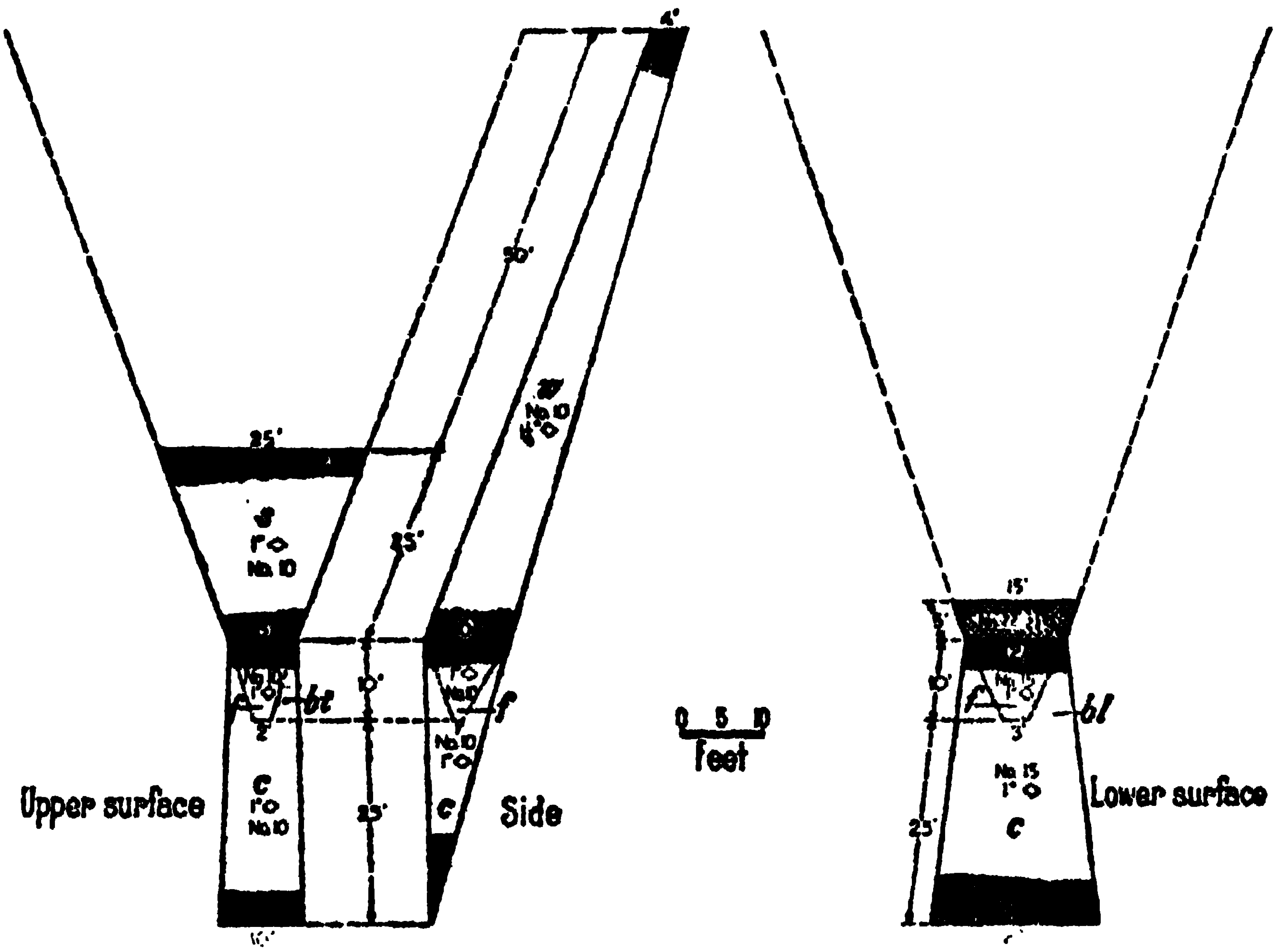

FIG. 4. A typical trawl net; diagrammatic views of upper, side, and lower surfaces; *bl*, belly; *bt*, bating; *c*, cod end, or bag; *f*, funnel-like affair; *s*, square; *w*, wing.

The beam.—The beam, which opens the mouth of the net by spreading the wings apart, is made of Oregon pine. It is cylindrical in form, 6 inches in diameter at the center, and 3 inches at the extremities, the tapering ends being provided with a hole through which a rope, for tying the beam to the main bridle, passes. When not in use, the fore part of the beam is supported on a roller (fig. 1, *rb*), and the after end on a wooden bar (fig. 1, *wb*), on the port side of the vessel. The length of the beam is dependent upon the size of the net and upon the power of the engine to be used for towing. Generally speaking, however, the beams are about 60 feet long.

The brails.—Homologous to the trawl heads of the modern beam trawls, the wooden brails, one on each end of the wings of the trawl net, are about 3 feet in length and are provided with a knob at the ends which holds the strings that keep the brails in place. As has been previously stated, the upper end is attached to the upper warp of the wing bridle and the lower end to the lower warp, holding the netting of the wings in an upright position during actual operation (figs. 3 and 5).

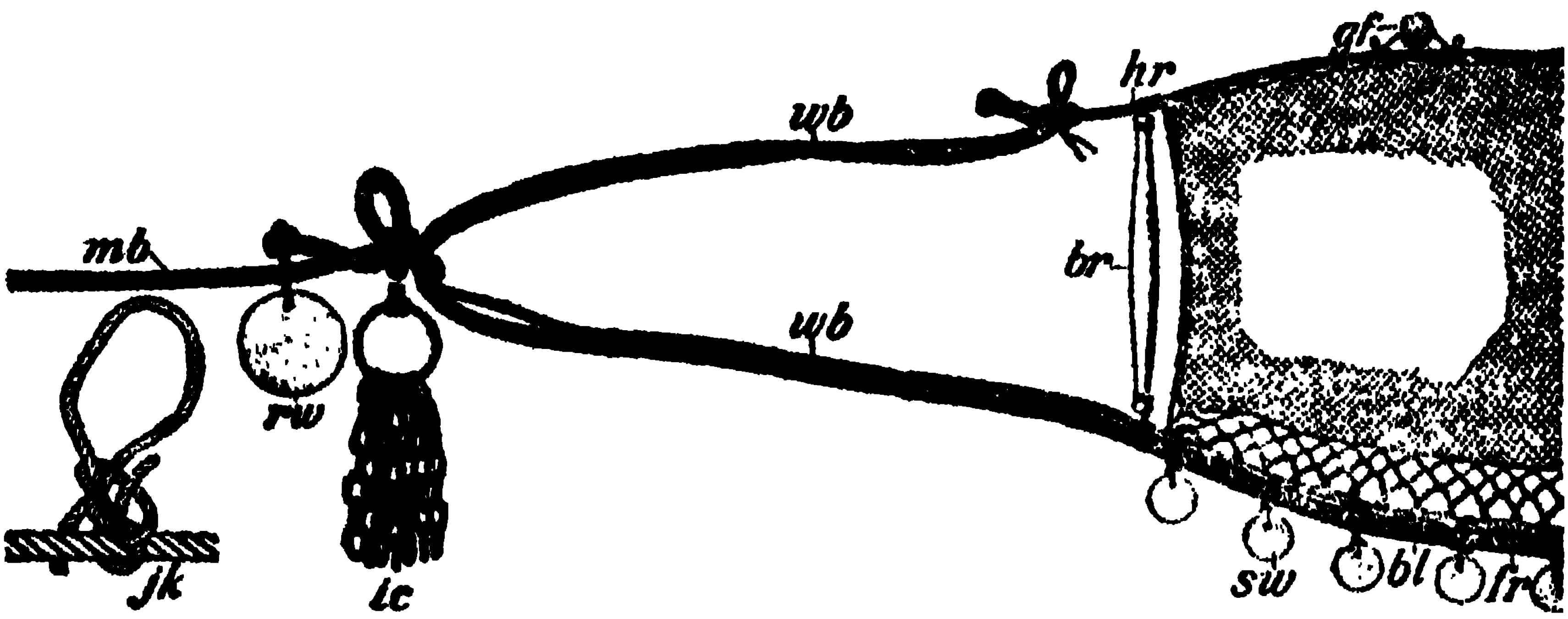

FIG. 5. A trawl net; end of one wing, showing various parts and accessories and its attachment to wing and main bridles; *bl*, balch line; *br*, brail; *fr*, foot rope; *gf*, glass float; *hr*, head rope; *ic*, iron-chain weights; *jk*, Japanese knot; *mb*, main bridle; *rw*, rock weight; *sw*, stone weight; *wb*, wing bridle.

The trawl net.—As has been mentioned in the foregoing paragraphs, the upper warp of the wing bridle is continued into the head rope and the lower warp into the foot rope. The head rope, which is about 135 feet long, is composed of two separate ropes, the upper and the lower, each being a 0.75-inch rope of either abacá or *kabo negro* although usually kabo negro, which is made up of the protective leaf base of the sugar palm [*Arenga pinnata* (Wurmb) Merr.]. They are seized (bound by windings of cord) to each other at irregular intervals.

More or less rounded glass floats, each with a diameter of about 4.5 inches and covered by a tight net (figs. 3 and 5), are attached to the entire length of the head rope; the distance between them varying from 36 inches at the fore ends of the wings to 12 inches at the center. Including those that are attached to the other portions of the net, as will be observed in the discussion of the trawl net proper, there are in all from 78 to 88 of these glass floats.

The foot rope, which measures about 175 feet long, is also composed of two ropes; the lower portion, the "foot rope" proper, is of the same size as the main towline, and the upper

part, the "balch line" to which the foot of the net is attached, is half the size of the foot rope and somewhat longer than the latter. Both are generally made of abacá, although the foot rope proper is sometimes of Japanese rice straw. When abacá ropes are used for the foot rope proper they are in fact made of old towline. The use of a weak rope for the foot rope is advantageous because in case of snagging or entanglement such a foot rope readily breaks, avoiding the danger of losing the entire net.

The balch line and the foot rope are seized to each other, the seizings being a little less than 2 feet at the wings and a foot distant at the "bosom," as the middle of the curve formed by the foot rope is called. Attached to the entire length of the foot rope in the manner shown in fig. 5, are from 80 to 100 disklike stone weights, each weighing about 2.2 pounds—the distance between them ranging from a little less than 2 feet at the fore ends of the wings to 1 foot at the bosom.

From the head and foot ropes, the net extends backward into the form of a gradually tapering bag. The net itself, which is about 110 feet long, is made up of several parts; namely, the wings, the square, the bating, the belly with a coarse-meshed anterior portion, the funnel-like netting inside the bating and the belly, and lastly, the cod end, or bag.

The wings (figs. 3 and 4, *w*), which form the anterior lateral extensions of the trawl net, have the front edge narrower than the rear end. Each wing is a little less than two-thirds the length of the entire net and is made up of twelve pieces of netting of No. 10 cotton twine [3] with a mesh of 1.25 inches. The entire length of its upper boundary is attached to the head rope, and its lower extremity to the foot rope.

On the "back" of the net, as the upper surface is known, the first division behind the central portion of the head rope is the square (figs. 3 and 4, *s*), a piece which is laced to the upper margins of the posteriormost third of the two wings and to the center of the head rope. To its free anterior edge are attached from three to five floats and behind this two or three more floats are attached to the netting of the body of the square in the manner shown in fig. 3, *s*. The netting is 1-inch mesh of No. 10 cotton twine.

[3] The numbers of the twines adopted are those of L. R. Aguinaldo, which are arbitrary numbers in his catalogue for 1931. The mesh is measured from knot to knot when drawn taut.

Behind the square is the bating (figs. 3 and 4, *bt*), which may be considered joined on one side to the square and on the other to the bag, although there is no actual boundary between it and the latter. It is a little less than one-tenth the length of the entire net and is of the same mesh and twine as the square.

On the "belly," as the undersurface of the net is designated, there is no structure that corresponds to the square of the "back," because the foot rope needs to extend a considerable distance farther back of the headline, in order that the fish, which have a tendency to strike upward when disturbed will encounter the net some distance from its entrance, and by the forward movement of the trawl net will be forced into the narrow end.

Beneath the bating and immediately behind the bosom is the belly proper (figs. 3 and 4, *bl*), which measures a little less than one-seventh the length of the entire net. The anterior portion is a piece of netting which is laced to the lower margins of the posteriormost fifteenth of the two wings. This piece has a mesh of from 2.50 to 3.25 inches and is of No. 22 cotton twine. The principal function of this wide-meshed netting of coarser twine is to prevent too much wear, as this portion of the net comes in direct contact with the sea bottom and is, therefore, subjected to severe rubbing. The remaining portion of the belly is 1-inch mesh of No. 15 cotton twine, a piece which corresponds to the bating on the upper surface of the net.

In the interior of the net between the bating and the belly is a funnel-like affair (figs. 3 and 4, *f*), the upper and side webbing being of No. 10 cotton twine and the lower of No. 15, both with a mesh of 1 inch. The mouth of the funnel is laced on its sides to the hinder ends of the wings; its upper edge to the junction of the square and the bating and its lower margin to the netting of the belly behind the wide-meshed portion. The four sides of the smaller opening of the funnel are supported by strings tied to the netting of the front portion of the upper and lower surfaces of the bag in such a way as to make a rectangular opening directed towards the bag. Through this opening, the fishes readily enter the bag, but find difficulty in escaping.

The posteriormost portion of the trawl net is the cod end, or bag (figs. 3 and 4, *c*), which is also 1-inch mesh of No. 10 cotton twine on its upper surface and of No. 15 beneath. This portion of the net measures a little less than one-fourth the length of

the entire net. Obviously, the weight in the cod end, or bag, is considerable since the catch is collected there. The silvery sheen of the fishes attracts the attention of sharks and other predatory marine animals with the result that in the latter's attempt to prey on the fishes in the bag, the net is generally damaged and the catch greatly reduced. Thus, old pieces of net, called the "rubbing pieces" or "false bellies," are attached to it in such a manner as to overlap each other protecting the net from too much wear and tear and at the same time concealing the catch. In actual operation, the edge of the bag is folded together and tied around with a string called the draw string or poke line (fig. 3, *d*).

Approximate cost of a fishing outfit.[a]

	Pesos.
Sampan	3,600 to 4,500
Engine	5,000 to 9,000
Three nets with complete accessory parts, at 500 pesos	1,500
Winch	200
Boat equipments (anchors, signal lights, etc.)	300
Dynamo and electric equipment	800
Reserve sail and canvas accessories	100
Other accessories	15
Total cost	11,015 to 15,915

[a] The above estimates were obtained through the kindness of Mr. Tomas Lichauco and Japanese owners of trawlers.

THE FISHING OPERATION

The trawling vessels, after receiving their provisions, oil for the engine, and trays and ice for the catch, start for the fishing ground very early in the morning.

On the way to the fishing ground, each member of the crew busies himself with the particular work assigned him. While the captain mans the vessel and the mechanic takes care of the engine, the other two or three men prepare the net for shooting. This consists in mending the net, tying the brails and stone weights, fixing the trawl warps, and tying the edge of the bag by means of the draw string. The deck is then cleared of unnecessary obstructions that may interfere with the fishing operation.

The fishing operation proper, which consists in shooting and hauling the trawl, may be done on either side of the vessel, depending on which side the beam of the trawl net is carried. As in most of the Japanese beam trawlers the beam is carried on the port side, the following description will deal with the technic of shooting and hauling the net on that side.

SHOOTING THE NET

This is a difficult phase of the fishing operation, requiring proper technic and skill that are acquired only with long experience, without which it would be impossible to operate this kind of net properly. A diagrammatic presentation of the entire shooting operation is shown in fig. 6.

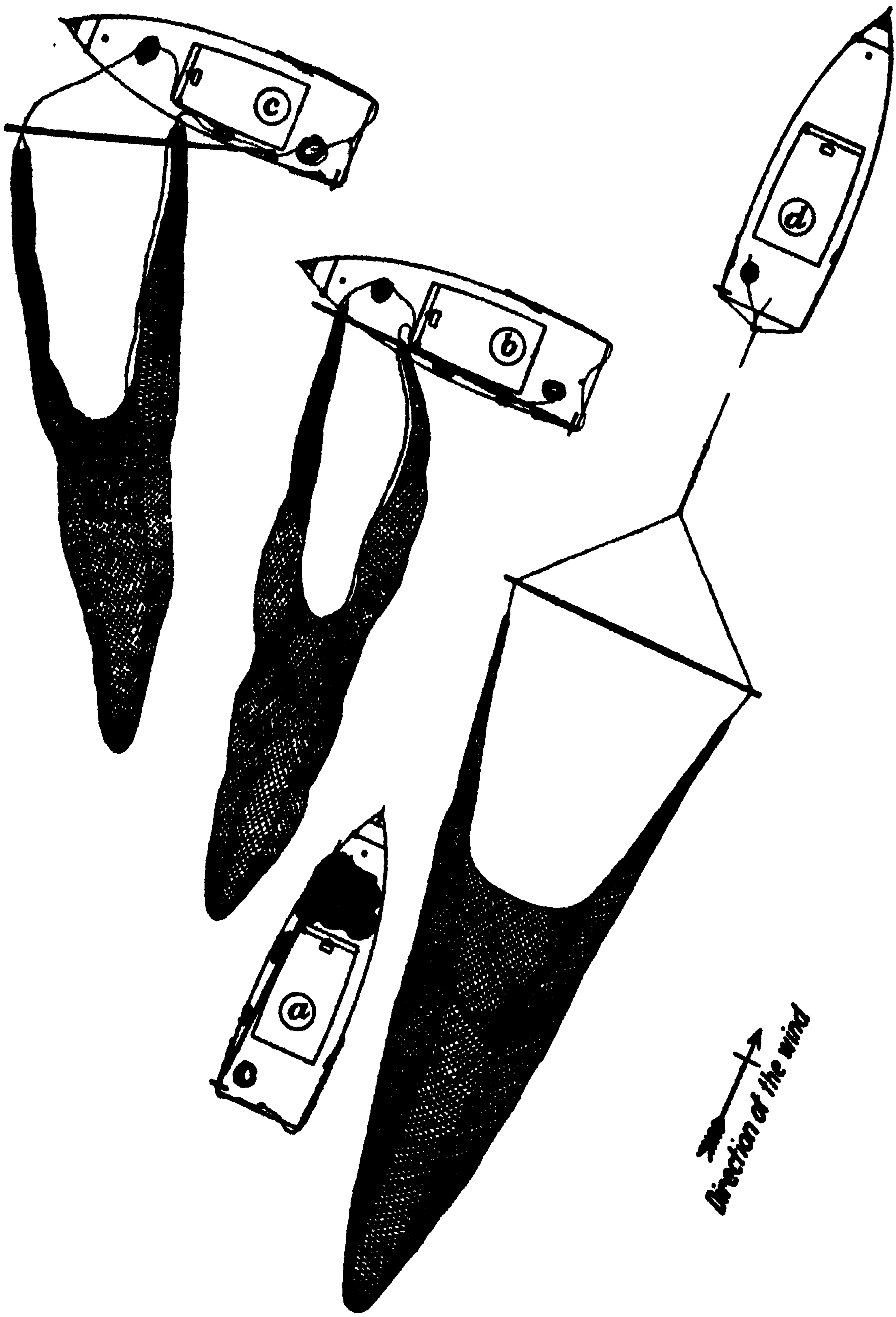

FIG. 6. The shooting operations; diagrammatic.

Upon arrival at the fishing ground, the speed of the boat is reduced. The vessel is hove to (fig. 6, *a* and *b*), thus placing it almost perpendicular to the direction of the wind, seeing to it that its port side is on the windward side. The engine is stopped. The bag, the open end of which has previously been closed by means of the draw string is paid out first, followed by the other parts of the net—the bating and the belly; the square provided with a quarter rope (a rope tied to the center of the front rim of the square, with its free end secured at the front edge of the wing towards the stern, which is especially useful when hauling in the heavy bag that contains the catch), and, finally, the two wings. The shooting is then halted, with the ends of the two wings still on deck (fig. 6, *b*). This is to ascertain that the direction of the drift of the net is such that while it is paid out, the vessel on the other hand, drifts to the leeward away from it.

When such is the case, the forward end of the beam (the end towards the bow), together with the disklike 25-pound stone weight and from one to three sets of iron-chain weights, is attached to the fore warp of the main bridle, before it is lowered (fig. 6, *c*). A rope (canting line) is tied to the after end of the beam (the end towards the stern); the rope is allowed to slack until this end of the beam is nearly level with the rail of the boat, but is not let loose of it (the canting line) until the forward end of the beam swings off from the vessel's side at an angle of 45 degrees, being slacked away gradually by the fore warp of the main bridle. The after end of the beam is then attached to the after warp of the main bridle with the corresponding weights, and it is lowered by pushing the beam down in such a way as to allow it to sink and at the same time square the trawl. The entire length of the main bridle is then paid out, followed by the main towline, the length of the latter being dependent upon the depth of the fishing ground as registered on the weighted line, which serves the purpose of a sounding apparatus, while in the meantime the vessel is steered to assume its original position and the engine run at only a fraction of its speed. The free end of the main towline is secured by means of a wooden pin to the towing tackle on the stern of the boat. The arrangement maintains the towing force in line with the long axis of the vessel (fig. 6, *d*).

A speed of about one and one-half miles per hour is then maintained, in order to keep the trawl net dragging at the bottom of the sea. Although sometimes the net is towed against the wind, generally it is dragged with the wind for the simple reason that it reduces the actual expense of the towing operation. The auxiliary sail is hoisted, but this is lowered when the wind changes. The boat is not steered during towing, but is left to drift, the trawl net serving as a rudder. Hence, in the old type of vessel, which is steered directly by means of a wooden rudder, the latter is raised on deck during the towing operation.

The trawl is towed in the manner shown in fig. 7, for from four to five hours, depending upon the abundance of fish and the nature of the sea bottom. It is then hove up, or hauled in.

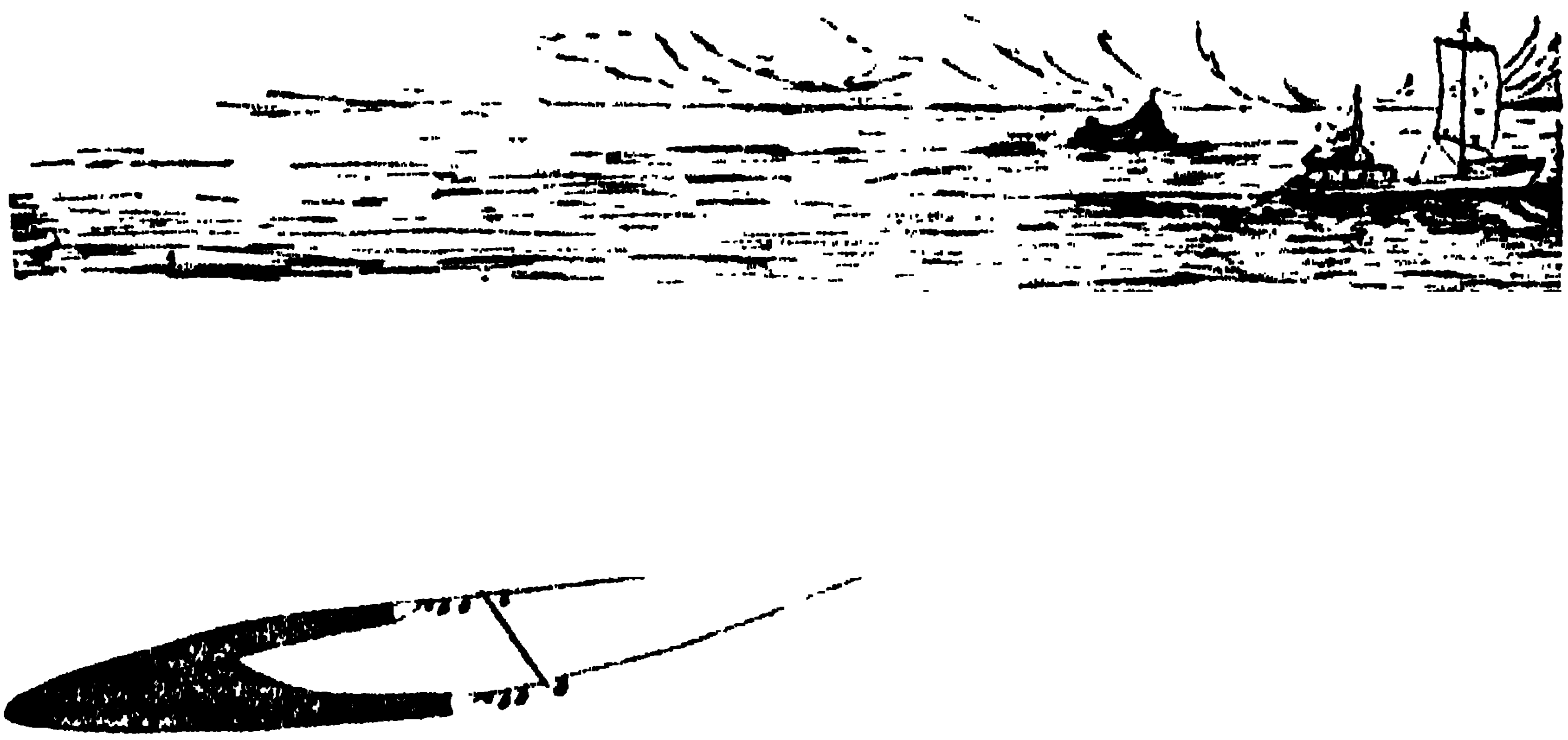

FIG. 7. The beam trawl in operation; diagrammatic.

HAULING THE NET

Preparatory to the hauling of the trawl, the portion of the main towline left coiled on deck at the stern of the boat is slipped through the roller (fig. 1, *rb*) towards the bow and then passed through the roller of the winch (fig. 1, *rw*) on the port side of the vessel. The arrangement of the warps at this phase of the hauling process is shown in fig. 8, *a*.

If the auxiliary sail has been used in the towing operation, it is then lowered. The pin that secures the main towline to the towing tackle is then removed and the main towline hauled in by one man with the aid of the winch. The warp that is hauled in is piled in the stern of the boat by another man. While the towline is being hove up in the above manner, the

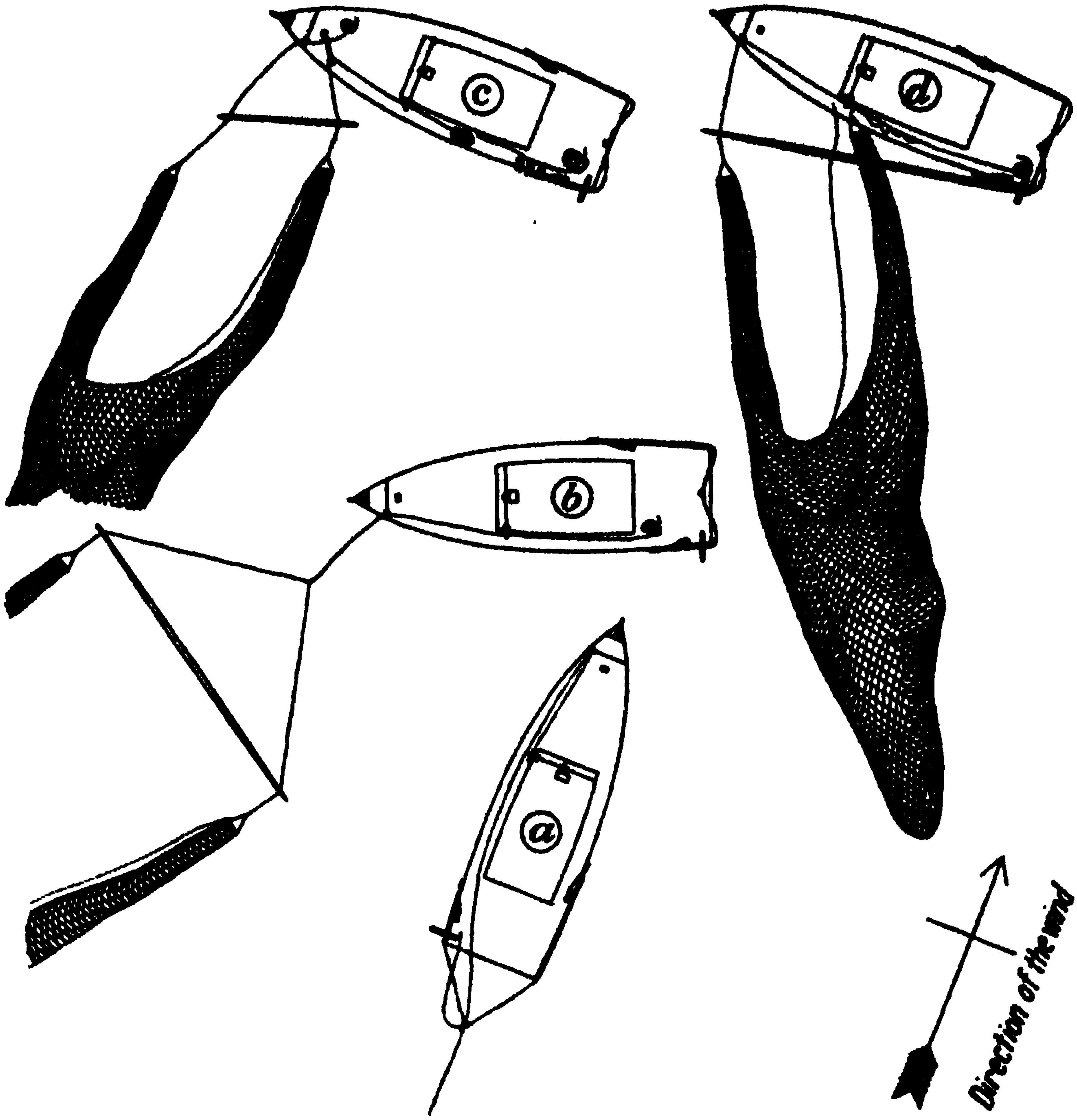

FIG. 8. The hauling process; diagrammatic.

boat gradually turns around and heads in the direction opposite to that held when the net was towed, which brings the port side somewhat to windward (fig. 8, *b*). The engine is then stopped.

When the main bridle reaches the roller of the winch its fore warp is pulled by two men through the roller near the bow of the boat, while the aft warp is lifted up and attached to a small derrick from whence it is pulled by one man with the aid of the winch (fig. 8, *c*, and fig. 9). Thus, the after end of the beam with the weights is hauled first, because the pull on the aft warp of the main bridle is faster than the pull on the fore warp. The after end of the beam having been lifted above the surface of the water, a rope (the canting line) is tied to it, and it is unloosened from the main bridle. The bridle and the brail of the after wing are then hove up, and the after wing of the

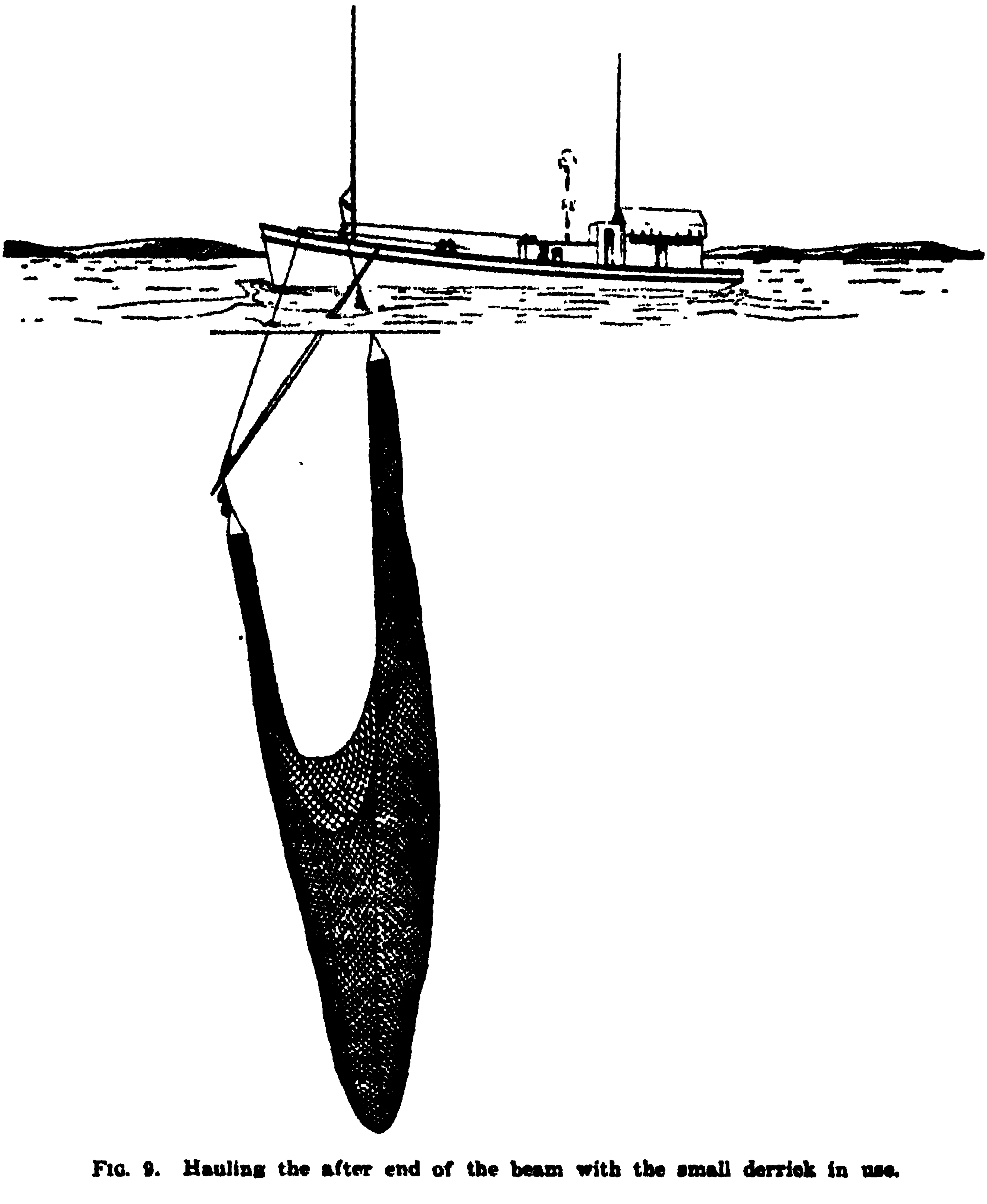

FIG. 9. Hauling the after end of the beam with the small derrick in use.

net is secured on deck, while the after end of the beam is gradually drawn toward the stern where it is made to slide on the wooden bar. The fore warp of the main bridle is then hauled faster by connecting it to the roller of the winch and the fore end of the beam with the weights hove up (fig. 8, *d*).

The two wings are then hauled by four men, two on each wing, while the captain pulls the quarter line, which is attached to the center of the front rim of the square, thus relieving some of the strain on the wings. The square, the bating, and belly are then hove up, until finally the mouth of the bag is raised above the water, where it is held in place by three men,

while the rest brail out the catch with a dip net. The bag is then lifted and the remainder of the catch allowed to fall on deck.

The boat is again set in motion and steered at full speed before starting a second shooting; in the case of the old type of vessel, the rudder is lowered. The diagrammatic presentation of the entire hauling process is shown in fig. 8.

While moving to the spot chosen for the second shooting, the fishermen mend the net and sort and ice the catch.

During each fishing trip the trawlers generally make from two to three hauls, after which they return in time to sell their catch to wholesalers for morning marketing.

THE CATCH

The catch, which consists of a writhing mass of varied creatures of the deep, both edible and nonedible—fishes (large and small), crustaceans, molluscans, and holothurians—is then sorted. The nonedible forms are thrown away, while the commercial species are group together into their respective kinds and placed in wooden trays with small quantities of crushed ice. The trays containing the catch are either stored in the holds of the boat or piled on deck.

As this fishing gear is adapted only to smooth sea bottoms such as sand, clay, or mud, free from débris, the bulk of the catch is made up of the so-called "ground fishes" which keep near the bottom in such an environment, although a limited number of the pelagic forms are also caught accidentally.

The following are the common species comprising the bulk of the beam-trawl catches.

Common species in beam-trawl catches.

Common English name.	Tagalog name.[a]	Scientific name.
Slipmouth.	Sapsap.	*Leiognathus caballus* (Cuv. and Val.).
Crevalle.	Salay-salay.	*Caranx* spp.
Nemipterus.	Bisugo.	*Nemipterus* spp.
Grunts.	Babansi.	*Therapon* spp.
Goatfish.	Saramullete.	*Upeneoides sulphureus* (Cuv. and Val.).
Croakers.	Alakaak.	Family Sciænidæ.
Mojarras.	Malakapas.	*Gerres* spp.
Shrimps.	Hipon.	*Penæus* spp.

[a] The Tagalog names are those used in the Manila markets.

Other species caught in lesser amounts.

Common English name.	Tagalog name.	Scientific name.
Gray sharks.	Pating.	Family Galeidæ.
Hammer-head shark.	Binkuñgan.	*Sphyrna zygaena* (Linnæus).
Cow-nosed ray.	Palimanok.	*Rhynoptera* spp.
Eagle ray.	Paol.	Family Dasyatidæ.
Piko eels.	Pindangâ.	*Muraenesox cinereus* (Forskål).
Sea catfish.	Kandulî.	*Arius* spp.
Flounder.	Kalangkao.	*Psettodes erumei* (Bloch).
Brills.	Dapang bilog.	Family Bothidæ.
Soles.	Dapang sinelas.	Family Soleidæ.
Barracuda.	Torsillo.	*Sphyræna* spp.
Cutlass fish.	Balila.	*Trichiurus* spp.
Cavallas.	Trakitillo.	*Caranx* spp.
Moonfish.	Chabita.	*Mene maculata* (Bloch).
Sergeant fish.	Gole.	*Rachycentrum canadum* (Linnæus).
Lactarius.	Pellan.	*Lactarius lactarius* (Bl. and Schn.).
Scolopsis.	Tagisang lawin.	*Scolopsis* spp.
Whiting.	Asohos.	Family Sillaginidæ.
Red snapper.	Bambañgin.	*Lutianus* spp.
Threadfin.	Mamalî.	*Polynemus* spp.
Drepane.	Mayang.	*Drepane punctata* (Linnæus).
Cardinal fish.	Lañgaray.	Family Ambassidæ.
Dorab.	Parang-parang.	*Chirocentrus dorab* (Forskål).
Flathead.	Sunóg.	*Platycephalus* spp.
Remora.	Parikit-bankâ.	*Echeneis naucrates* (Linnæus).
Grouper.	Lapo-lapo.	Family Serranidæ.
Crabs.	Alimasag.	*Neptunus pelagicus* Linnæus.
Window shell.	Kapís.	*Placuna placenta* Linnæus.
Squids.	Pusít.	Cephalopoda.

EFFECT OF BEAM TRAWLING ON THE FISHERY RESOURCES

While it has been repeatedly alleged by native fishermen that this method of fishing is very destructive to the fishery resources of the Islands, such can easily be dismissed with a negation for lack of specific evidence. Just like the other fishing nets, the beam trawl is a legitimate fishing appliance which is universally recognized. In as much as the eggs of the commercial food fishes, with few exceptions, are pelagic, or floating, and because of the high temperature in the Tropics, the same eggs

readily hatch, the claim that the beam trawl causes a general destruction of the spawn of food fishes is unwarranted.

Although it cannot be denied that small amounts of immature fishes are included in the hauls of the beam trawls, still the destructive effect is negligible if it be considered that without the use of such a gear in Philippine waters vast quantities of the demersal forms of animal life in our seas would remain untouched which, if viewed from the economic standpoint, is just as wasteful, if not more wasteful, than destroying a fraction of a product other parts of which are utilized. The destructive effect, if any, wrought upon the fishing grounds cannot be attributed to this method of fishing alone, for in fact, all other types of fishing gear are just as harmful, if not more so. Depletion which may come about in the future as the natural outcome of the continuous and unregulated activity of beam trawlers may be prevented by the Government exercising complete control of this method of fishing, and guarding against overactivity in order to insure and conserve the richness of our seas.

The adoption of this method of fishing is recommended to Filipino fishermen for use in Philippine waters. The trail has been blazed, and it is hoped that the pioneering spirit exemplified in the business initiative of a foreign element in the Philippines will be followed and emulated by more of the native fishermen.

ILLUSTRATIONS

FIG. 3. Perspective view of the gear, showing important parts; *b*, beam; *bl*, belly; *br*, brail; *bt*, bating; *c*, cod end, or bag; *d*, draw string, or poke line; *f*, funnel-like affair; *fr*, foot rope; *gf*, glass floats; *hr*, head rope; *iw*, iron-chain weights; *mb*, main bridle; *rw*, rock weight; *s*, square; *sw*, stone weights; *w*, wing; *wb*, wing bridle.

4. A typical trawl net; diagrammatic views of upper, side, and lower surfaces; *bl*, belly; *bt*, bating; *c*, cod end, or bag; *f*, funnel-like affair; *s*, square; *w*, wing.

5. A trawl net; end of one wing, showing various parts and accessories and its attachment to wing and main bridles; *bl*, balch line; *br*, brail; *fr*, foot rope; *gf*, glass float; *hr*, head rope; *iw*, iron-chain weights; *jk*, Japanese knot; *mb*, main bridle; *rw*, rock weight; *sw*, stone weight; *wb*, wing bridle.

6. The shooting operations; diagrammatic.

7. The beam trawl in operation; diagrammatic.

8. The hauling process; diagrammatic.

9. Hauling the after end of the beam with the small derrick in use.

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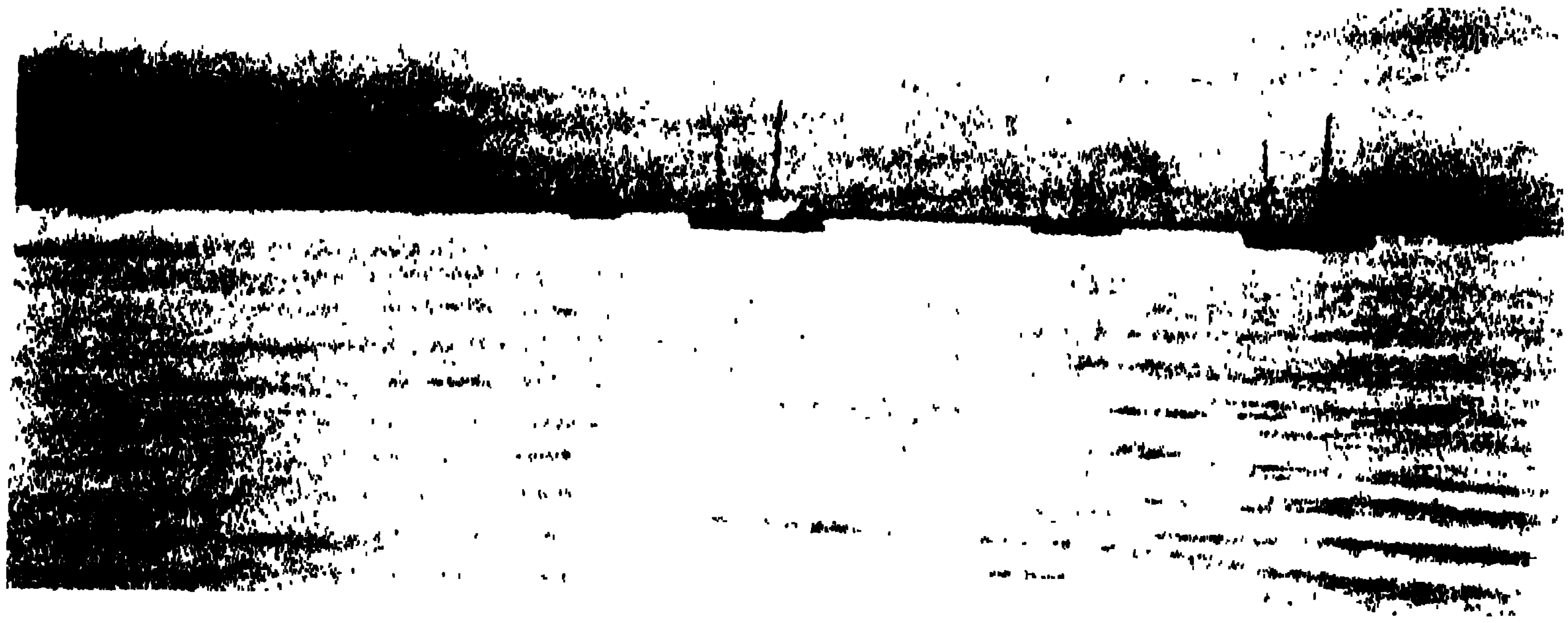
PLATE 1.



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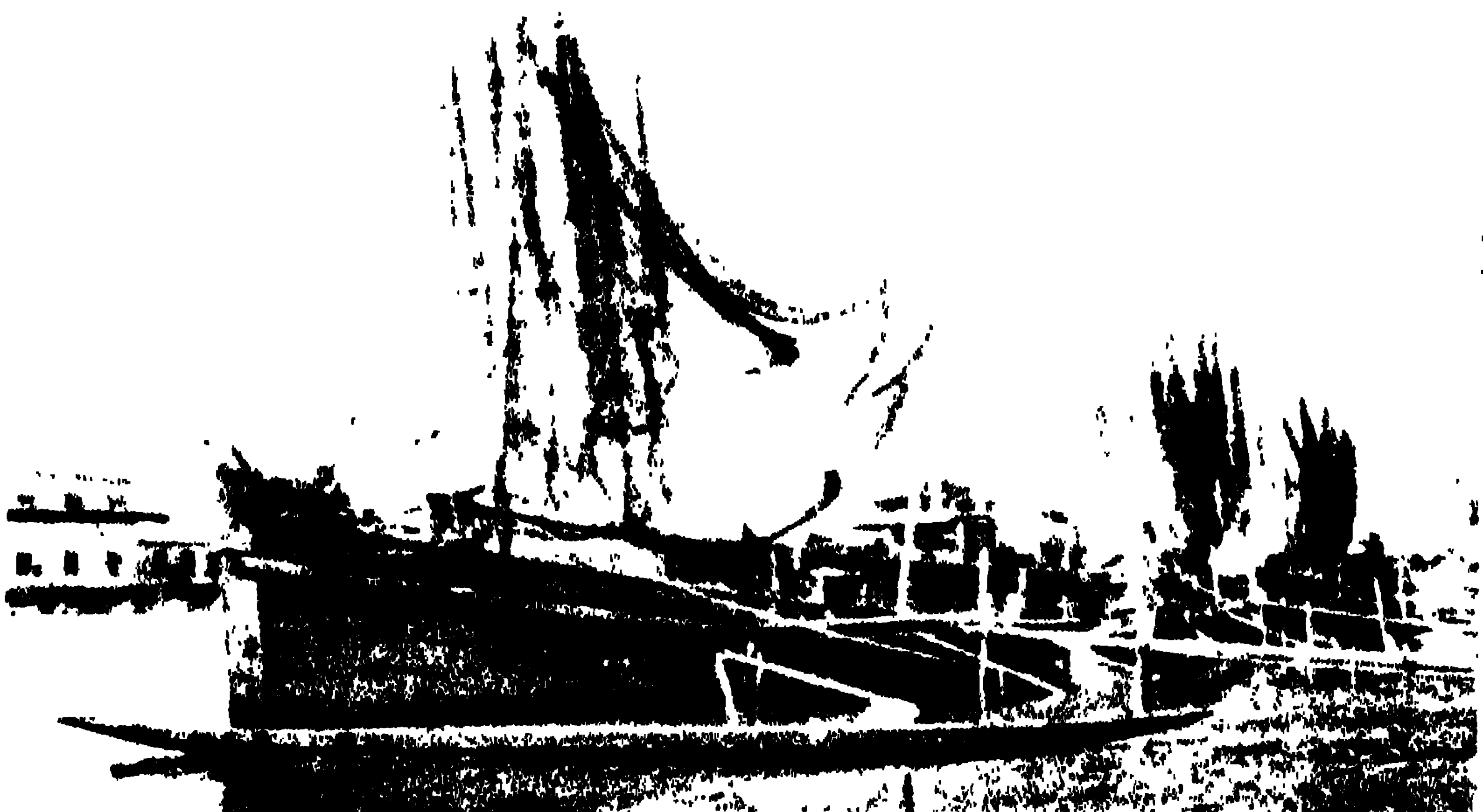

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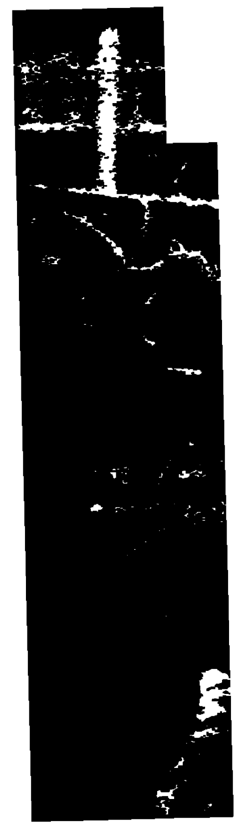
PLATE 2.



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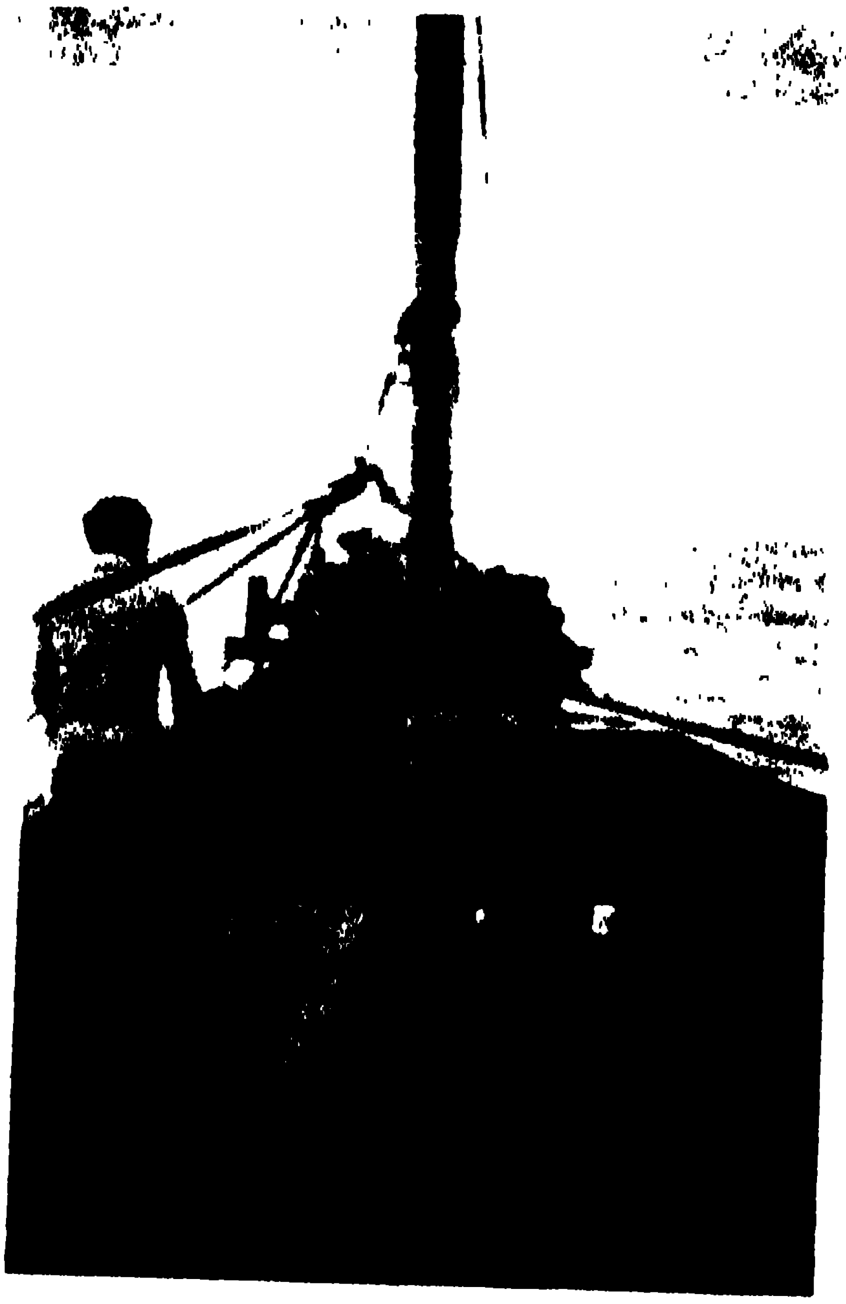

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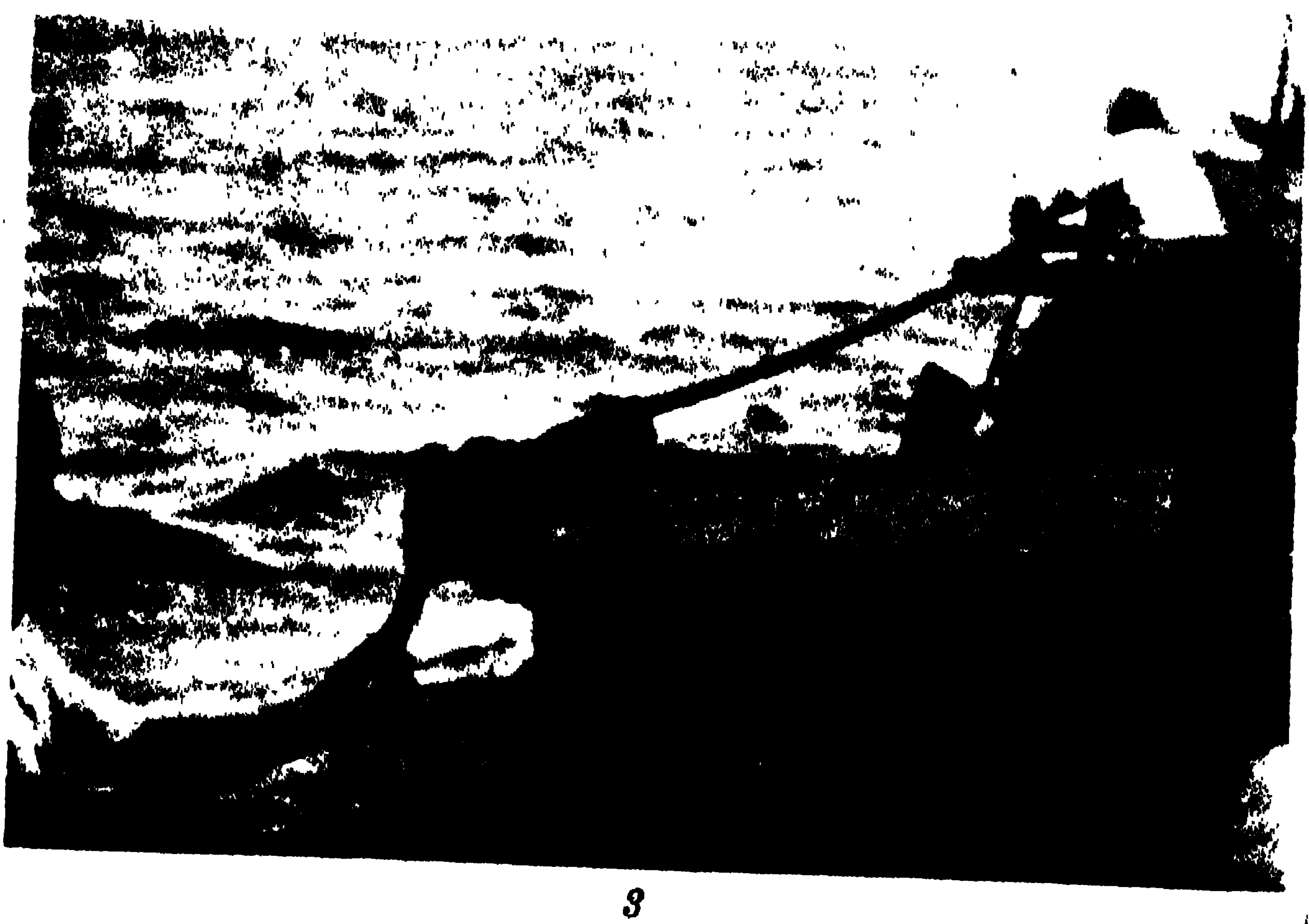

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PLATE 4.

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PLATE 5.

THE FISHERIES OF LAKE SAMPALOC, SAN PABLO LAGUNA PROVINCE, LUZON

By FLORENCIO TALAVERA

Of the Division of Fisheries, Bureau of Science, Manila

FOUR PLATES AND NINE TEXT FIGURES

INTRODUCTION

Lake Sampaloc, the largest of the nine beautifully set crater lakes in the San Pablo Valley,[1] is situated near the progressive town of San Pablo and because of this proximity its fisheries are of considerable economic importance.

Even in the absence of definite records regarding the income and value of the resource, past and present, there is no doubt that these fisheries have played a significant rôle in the life of the inhabitants of this district. It is told that in the early days, when community life in this region was more or less isolated, the people of San Pablo and vicinity were amply supplied with fish taken largely from this lake. The supply at that time was more than sufficient to satisfy the demands of a limited population. The lake continued to be sufficiently productive up to the time when, for civic reasons, the municipality of San Pablo caused the water to be lowered to its present level, which is approximately 10 meters below its former height. Since the lowering of the lake there has been a marked decrease in the annual yield of the fisheries. This assertion was concurred in by all persons interviewed, including fishermen, municipal officials, and several old residents of the town.

It is true that the diminution in volume and area of the water has had a limiting biological influence upon fish life in the lake, but that this alone is wholly responsible for the marked decrease in the natural supply cannot be true. Obviously, therefore, the explanation of the alleged depletion must be sought in other causes. The consideration of these is the principal object of the present survey.

[1] Census of the Philippine Islands 1 (1918) 172.

The situation as found is this: The fisheries to-day are just as important as formerly from the point of view of the people supplied by them. According to a local municipal official, there are at present no less than two hundred families living around the lake who are more or less dependent upon the fisheries for their livelihood. The annual yield shows a gradual decline. There has been no attempt to increase the natural supply by introducing or transplanting fish of similar or different species. There are no protective measures for the perpetuation of the fisheries. The town of San Pablo is progressing rapidly and with progress has come an increased population and an increased demand for fish. Apparently, this demand has taxed the capacity of the species in the lake, and, unless the situation is remedied through administrative measures and scientific means, it will be only a matter of time until the supply is depleted.

LOCATION AND DESCRIPTION OF LAKE SAMPALOC

Geographically, Lake Sampaloc is situated south of Laguna de Bay and lies in about 14 5′ north latitude and 121° 20′ east longitude. It is bounded on the north by Laguia, Nagcarlang, and Atimbla Mountains; on the northeast by Malauban and Basiling; on the east by San Cristobal and Banahao; on the southwest by the town of San Pablo; and on the west by the barrio of San Lucas. The rim of its southwestern slope is only about a kilometer from the railroad station of San Pablo.

The lake is roughly oval in outline with an estimated area of 1.12 square kilometers. The long diameter extends north and south and measures about 1.25 kilometers; the short diameter is about 1.15 kilometers; the distance around the shore is approximately 4 kilometers. The lake is surrounded by high cliffs which rise abruptly from the water's edge on all sides except on the northern flank where the surrounding land is comparatively low and flat. The shore line is irregularly circular and forms two indentations on the northern sector. The surface of the lake stands about 80 meters above sea level during the greater part of the year.

The lake is rich in plant life. Growing abundantly in the littoral area are water hyacinths, *Eichornia crassipes* (Martius) Solms; water lilies, *Nymphaea* sp.; and tape grass, *Vallisneria* sp. Other less conspicuous floating and submerged forms also abound. Blue-green algæ, *Clathrocystis* sp., thrive well in the lake, appearing periodically in enormous quantities. At the

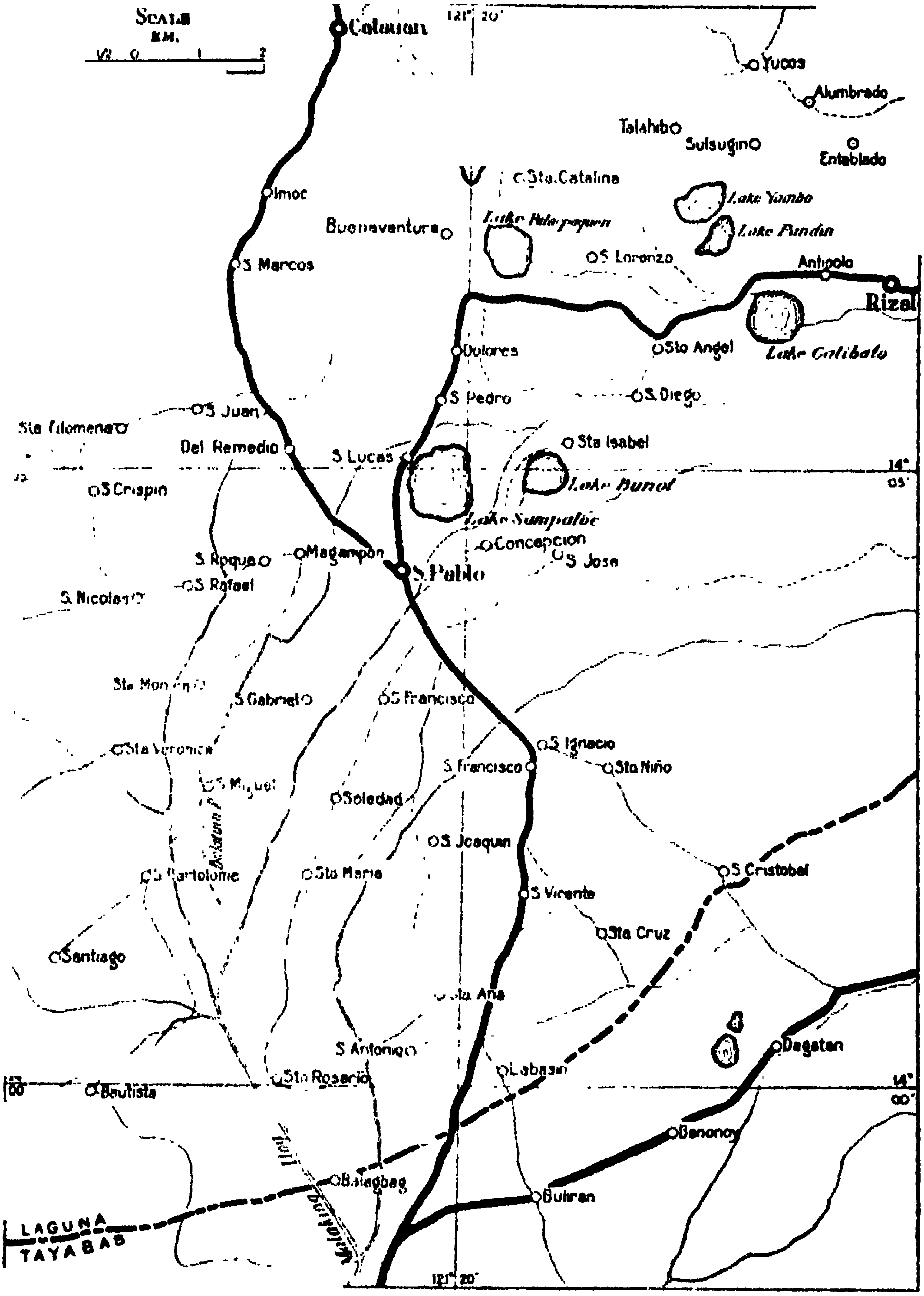

FIG. 1. Showing the location of Lake Sampaloc, San Pablo, Laguna Province, Luzon.

time of the survey (February, 1931) these unicellular plants covered the entire upper layer of the water to such an extent that the lake was transformed into a sea of green. The algæ were noticeably thickest on the western shore, having been carried there by the northeast wind. The repulsive algal smell

was already beginning to emanate from the decomposing mass on the shore.

The shore of Sampaloc is narrow and descends abruptly to a considerable depth. About 40 meters from the shore a depth of 17 meters is general. The deepest sounding made at the central portion is 22.5 meters, which appears to be the maximum depth of the lake. It was found during the survey that the eastern half of the lake is deeper than the western and likewise the southern exceeds the northern in average depth.

Lake Sampaloc has only one outlet, which is narrow and shallow, about 3 meters wide at the widest and about 50 centimeters at the narrowest part and with a minimum depth of about 30 centimeters. This opening is located on the northwestern shore near the barrio of San Lucas. The outflow empties into a creek connecting with Balatuin River which joins the Malakingtubig-Quipot course that flows into the Malaking Ilog system draining into Tayabas Bay.

Apparently the water supply of the lake depends mainly upon rainfall, which is comparatively abundant, as rain occurs continually in this region throughout the year. It is possible that part of the water coming into the lake reaches it through springs on its floor. A number of springs and tiny creeks are found around the shore. It is very likely that seepage from the bordering areas and surrounding higher grounds, presumably coming from Banahao and the adjacent mountains, contributes also to the water supply of the lake.

STATUS OF THE FISHERIES

Lake Sampaloc is under the jurisdiction of the municipality of San Pablo. Its fisheries are free and open for the people to utilize as a public natural resource and so far as known, with one exception, fishing has always been entirely unrestricted. During 1916, for a period after Edward H. Taylor, of the Bureau of Science, had introduced large-mouthed black bass, *Huro floridana* (Le Sueur), into the lake, the local government thought it necessary to enforce a protective fishery measure. At present, fishermen may catch fish of any size and as many as possible at any time, may use any kind of appliance, and are untaxed for the right and privilege of fishing.

INCOME AND VALUE OF THE FISHERIES

Exact figures regarding the quantity and value of the fish obtained from Lake Sampaloc are not available, due to the fact

that no records of catch and sale are kept by either the fishermen or the municipality. Any information on this matter must necessarily be based upon what the fishermen themselves furnish verbally, which data generally represent the lower estimate. According to the three owners of *sakag* outfits (the most important fishing appliance in the lake) the amount of shrimps caught every day by one sakag outfit is from 10 to 50 liters, valued at from 1 to 5 pesos or from 10 to 50 pesos daily for the ten outfits that are in operation at present. Besides these sakag outfits there are other smaller apparatus which capture considerable quantities of shrimps every day. No approximate estimate on the value of this catch can be obtained. The yield of the dalag fisheries is just as much as or slightly less than that of the shrimp fisheries. The income from the other species caught is uncertain and therefore considerably less. All in all, a conservative estimate of the annual income from these fisheries is placed at about 24,000 pesos.

SPECIES IN THE LAKE

The principal species found in the lake are mudfish (*dalag*), *Ophicephalus striatus* Bloch; sleeper (*bia*), *Hypseleotris agilis* Herre; eel (*palos*) Anguillidæ; and shrimps (*hipon tagunton*), *Palaemonetes* spp. The shrimps are by far the most abundant and are, therefore, the most important. There are at least two kinds of shrimps belonging to the group of Palaemonidæ, which abound in enormous, apparently inexhaustible, quantities. The dalag comes next in importance. A considerable quantity is obtained. The sleeper, or bia, ranks third in value. Eels are caught occasionally and constitute but an incidental portion of the fisheries. On the whole, considerable quantities of these fishes are captured in various ingenious appliances which are described in the following paragraphs.

The actual supply of the species in the lake is not known. Of the life history and habits of these nothing definite can be stated at present.

MARKETING

Practically all of the fish obtained from the lake are disposed of locally, where there is a great demand for them because of their special and characteristic flavor. Dalag and shrimps from Lake Sampaloc are preferred by residents about the district, being considered far superior in quality to those obtained from any other region. Large quantities of shrimps, fresh and cooked, are sold in the San Pablo public market daily.

FISHING METHODS

The most common fishing appliances in use in Lake Sampaloc are the *sakag*, *dala*, *biakus* or *saykit*, *kasag*, *paloob* or *pataob*, *bonbon*, *balumbong*, *patubog*, *kitang*, and *kawil*.

Sakag.—The sakag outfit (fig. 2) is operated by two men and consists of two units; namely, a large baglike dip net, which is also called sakag, and an especially constructed bamboo raft provided at the fore end with a framework upon which the gear is mounted and worked on a lever. The net, which is of No. 20 or 40 cotton twine with meshes varying from 7 to 15 millimeters stretched, is rigged on two bamboo poles, each 8

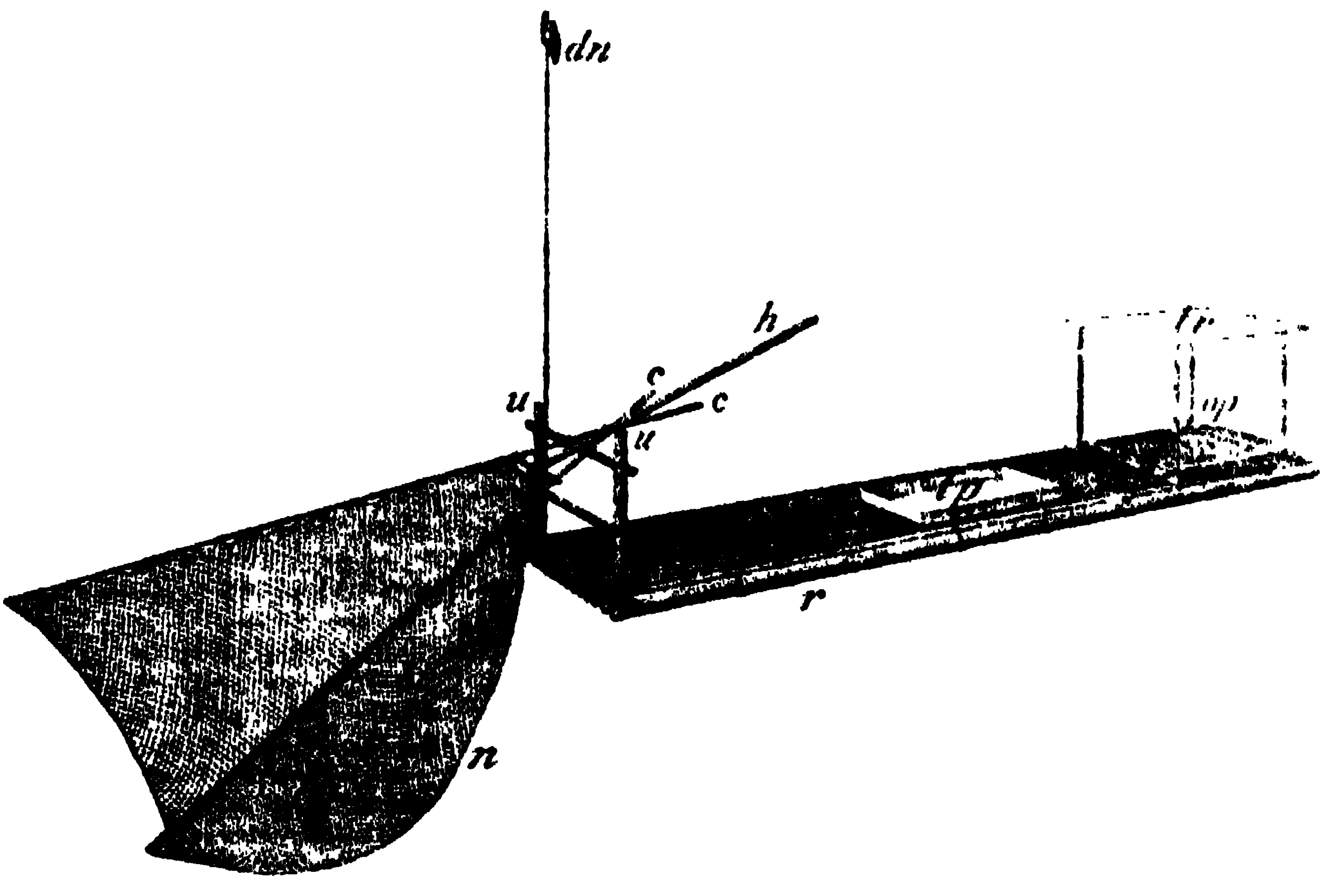

FIG. 2. Sakag outfit; *r*, raft; *n*, net; *h*, handle; *c*, crosspieces; *u*, upright; *tp*, tin pan; *tr*, tin roof; *dn*, dip net; *op*, oar pin.

to 10 meters long and crossed near one extremity. The raft is about 6 meters long and 2 meters wide and is equipped with an H-shaped bamboo framework at the prow, a tin container for the catch in the center, and a sort of shelter at the stern. The raft is sculled by means of an oar (fig. 4). On the framework (fig. 3), which serves as a fulcrum, are mounted the two cross poles of the net and to the upper, or shorter ends of the crosspieces, is lashed an accessory handle, which is utilized in raising the net. When lowered, the longer arms of the cross poles allow the net to hang vertically in the water so that as the raft is

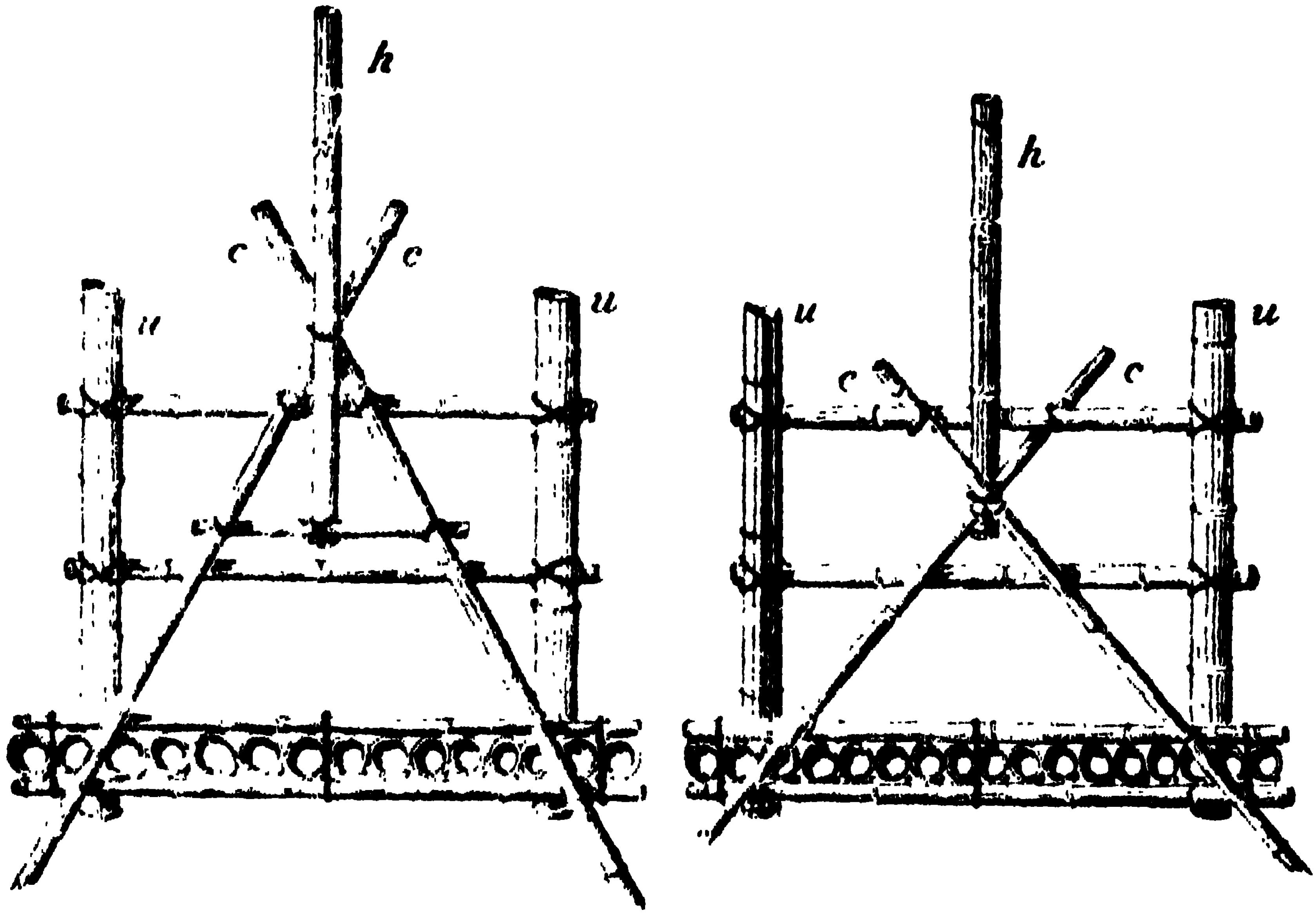

FIG. 3. Two methods of mounting the crosspieces of a sakag outfit; c, crosspieces; h, handle; u, upright.

rowed forward the net is transformed into a large bulging pocket. To raise the net one of the fishermen grasps the accessory handle and pulls it down with all his weight until its end is secured in a noose attached to the flooring of the raft. He then gathers the bunt and shakes the net, allowing the fish to accumulate in a heap, from which he scoops them with a long-handled dip net. The catch, usually made up of shrimps, is transferred to the tin container. The time interval between net liftings depends upon the judgment of the fishermen but generally it is between five and ten minutes. The net is operated close to the shore where the shrimps abound. A complete sakag outfit would cost from 100 to 150 pesos.

Dala.—The dala is a conelike net that is cast and drawn, not set, and is usually about 3 meters high and 17 meters around

FIG. 4. Oar for sakag; b, blade.

the heavily weighted base. The webbing, entirely knitted by hand, is of No. 20 or 40 cotton string and its meshes vary from 20 to 30 millimeters stretched. The weights, molded from molten lead in the form of small rectangular bars with short up-turned ends, are each about 6 centimeters long and 10 millimeters thick and weigh about 24 grams; these sinkers are grooved lengthwise and are strung about 4 centimeters apart on the bottom rope. At the apex of the cone is attached a warp or retrieving line looped at the end. The loop is slipped around the wrist of the arm over which the net is carried in a sort of pleated fanlike arrangement. A right-handed fisherman preparing to throw the dala holds the upper part of the net over his right arm; he takes an outer section of the net just above the weights and slings it around the curve of his arm; then he holds another section in his right hand; and, with the left hand carrying a third section, he swings the net to gain momentum and then throws it forward so that the net spreads out over the water in a circle. Because of the heavy weights the circular margin, as soon as it spreads out, sinks and closes rapidly thus entrapping the fish before they can escape by "sounding." In Lake Sampaloc the dala is thrown either from the shore or from a bamboo raft to catch dalag and other species that come within its scope. A new dala would cost from 20 to 30 pesos.

Biakus, or saykit.—The biakus, or saykit (fig. 5), is a small drag seine of fine-meshed *sinamay* (cloth woven from the fiber of Manila hemp, or abacá, *Musa textilis* Née), having two short rectangular wings and a long bag or pocket between them. The netting is attached to a stout abacá twine on all sides. The seine carries no floats along the upper line nor weights on the foot rope. Attached to the end of each wing is a bamboo brail almost twice as long as the width or depth of the net, and from the upper extremity of each brail is stretched a strong abacá cord to the middle point on the upper border of the mouth of the pocket. This cord holds that portion of the bag above the water when the net is in use. Two persons each holding a brail drag the net along the shallow area on the shore, lifting it every once in a while in order to deposit the catch in the pocket, which is pursed at the extremity by a purse string. The saykit is intended solely to capture shrimps. A net of popular size (wings, 2 meters long by 1.5 meters wide, and pocket, 2 meters long) is valued at no less than 5 pesos.

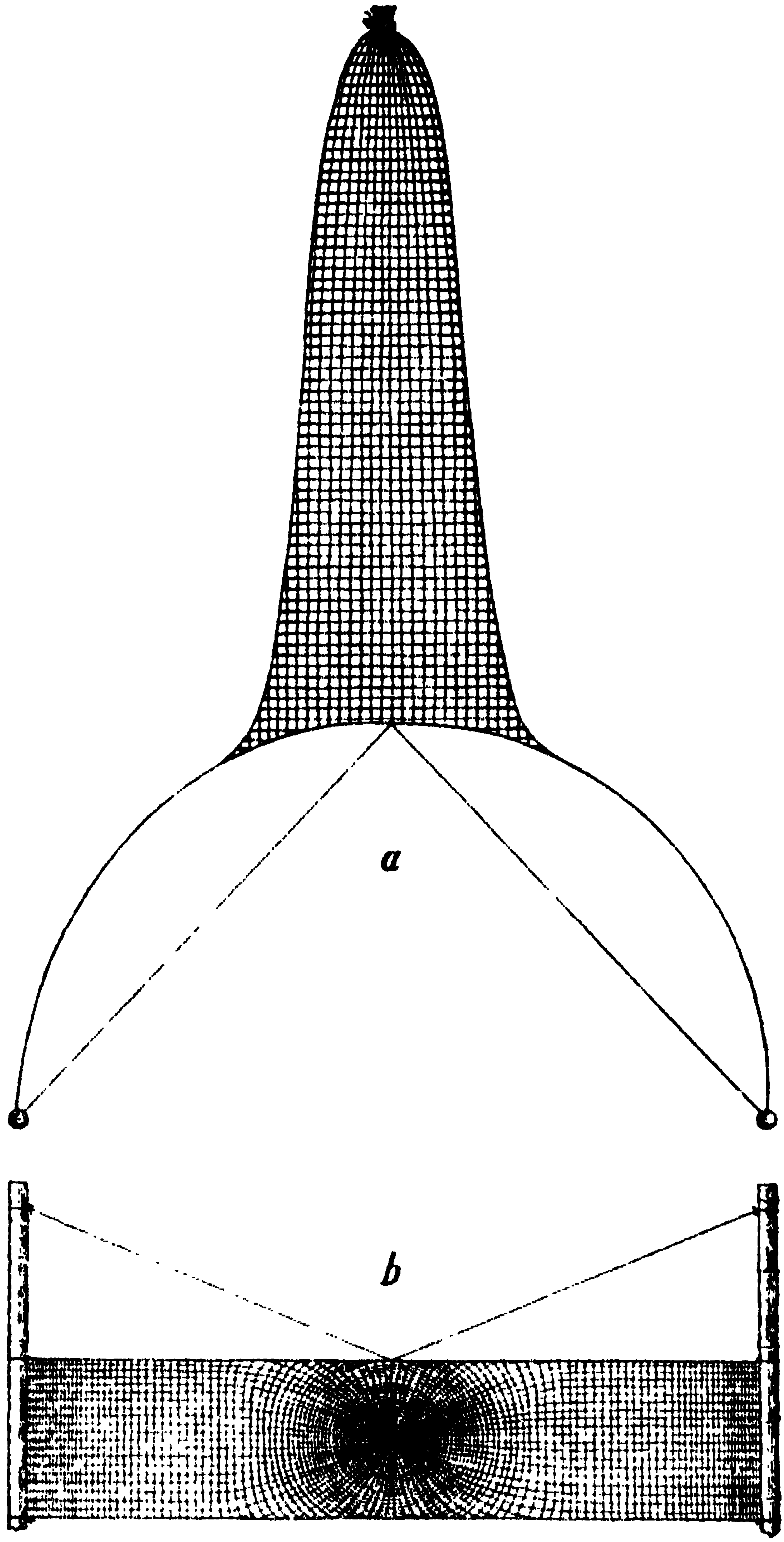

FIG. 5. Biakus, or saykit: *a*, top view; *b*, front view.

Kasag.—The kasag (fig. 6) is a portable rectangular scoop net or dip net of fine-meshed sinamay netting hung on a framework of crossed bamboo slats, each about 6 centimeters wide and 150 centimeters long, lashed at the intersection and held rigid by a stout abacá cord fastened to the opposite ends of the crosspieces. The sinamay netting covers the bottom completely and the three sides halfway to the top, leaving one long side open to be used as the mouth of the scoop. A necessary complement to the dip net is the T-like "driver" (*sagsag*) which is made up of a bamboo-pole handle about 3 meters long and 3 centimeters in diameter and a crosspiece of bamboo slat about 1 meter long and 5 centimeters wide. In operation, the dip net is simply set at a certain shallow place near the shore and the sagsag is worked around to drive the shrimps into the mouth of the scoop. After the shrimps are driven in, the net is raised and the catch is transferred to a fish basket that is tied around the waist of the fisherman. Another location is then selected for the kasag and the performance is repeated. A kasag outfit would cost about 2 pesos, when new.

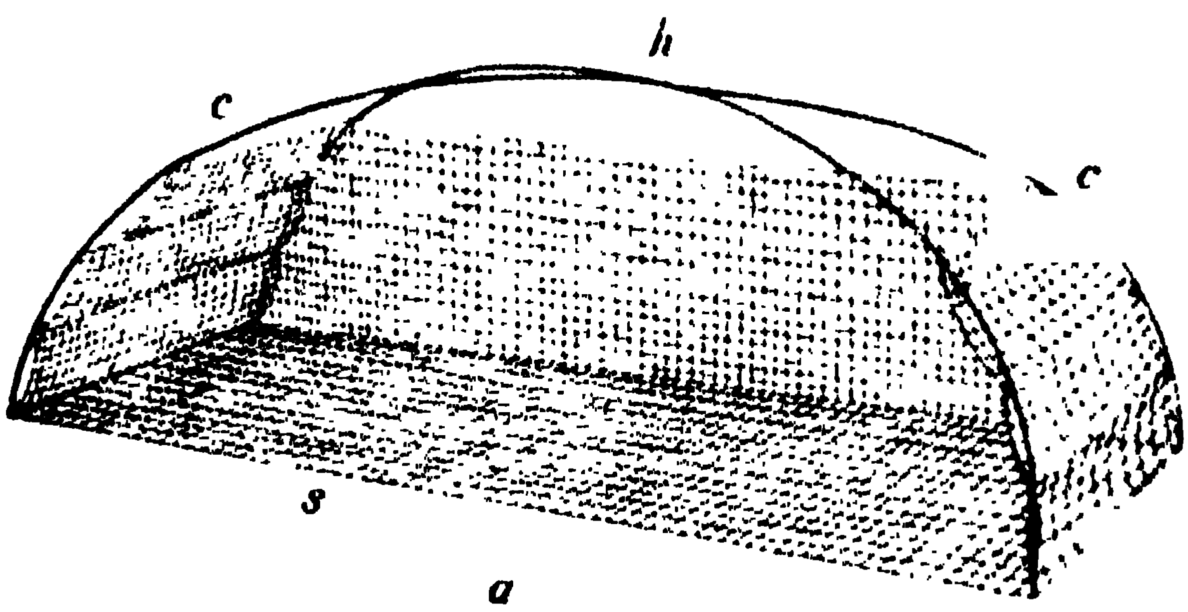

FIG. 6. Kasag outfit, *a*, kasag; *b*, driver, *c*, crosspieces; *h*, handle; *s*, sinamay.

Paloob, or pataob.—The paloob, or pataob (fig. 7), is one of the most ingenious devices for capturing dalag. The habit of this particular species is to seek shelter in quiet shady nooks and this is considered in the construction of the paloob. It is made up of a number of bamboo stakes, each from 8 to 10 centimeters wide and 80 centimeters long, driven close together in

the form of a rectangular pen, 70 centimeters long and 40 centimeters wide, with the entrance provided with a drop door which is held to its upper position by abacá twine attached to a trigger inside the inclosure. The top of the pen is usually covered by twigs or dried coco-palm leaves. A sort of nest or shelter made of switches and dried coco-palm branches and leaves is built around the front of the entrance to attract and lure the fish into the trap, which is set in shallow water along the shore. The dalag, after entering the pen, eventually touches the trigger, which causes the door to fall suddenly and prevents escape. The catch is brailed out with a dip net. The paloob is the most important method of capture for dalag in Lake Sampaloc, where there were no less than two hundred in use at the time of the survey.

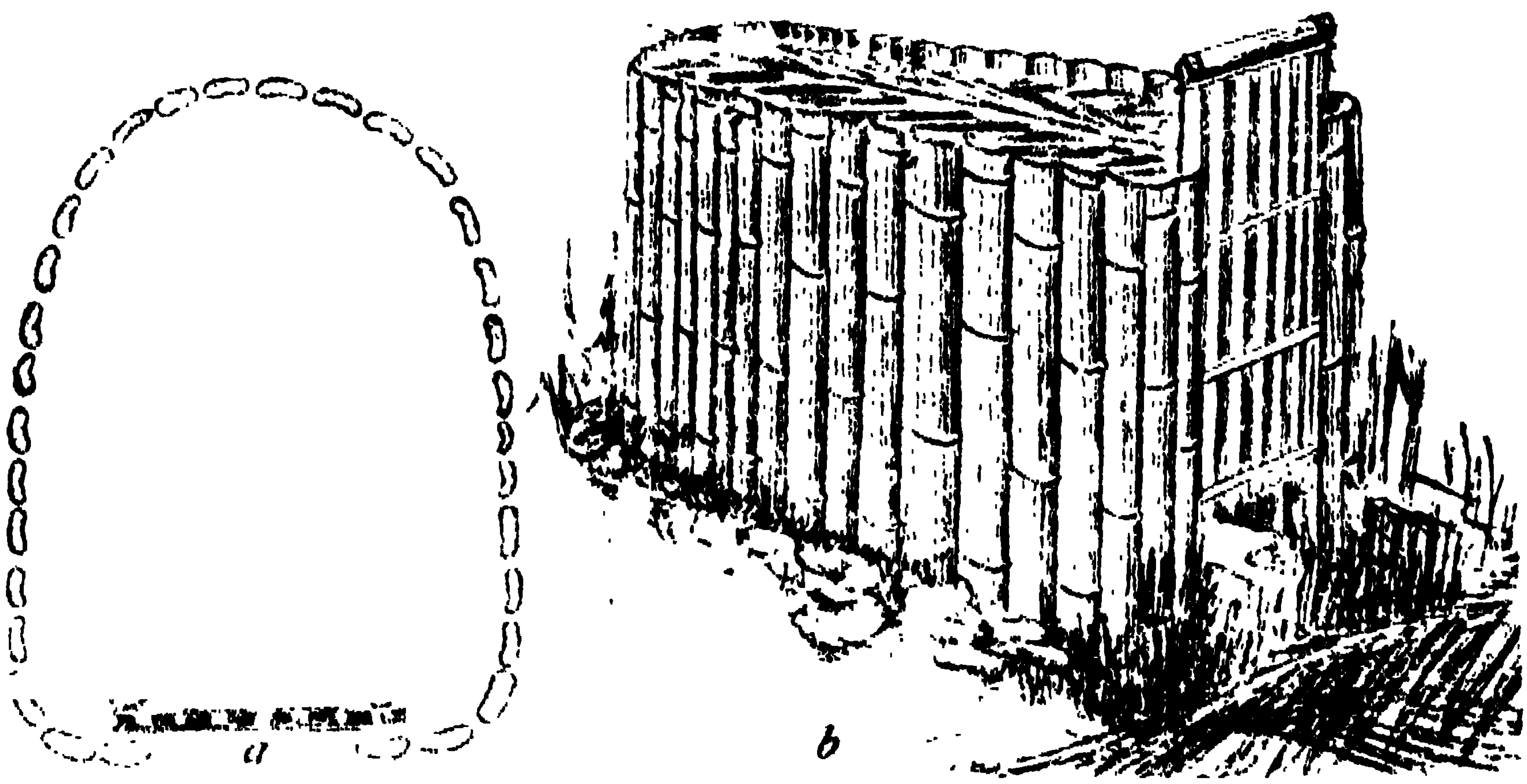

FIG. 7. Paloob, or pataob; *a*, plan; *b*, paloob set near the shore of the lake.

Bonbon.—The term "bonbon" (Plate 2, fig. 1) refers to an artificial nest or shelter built in shallow water along the shores. The nest may consist of a patch of water hyacinths, water lilies or lotus, dried coco-palm branches and leaves, or bundles of dried twigs or switches, staked around with bamboo or wooden sticks (*tulus*). The bundles of twigs, locally known as *sigiw* or *talabog*, may be set on the bottom completely submerged or on some improvised structure to hold them partially under water. The sigiw is intended particularly to provide shelter for shrimps. The other kinds of bonbon are made primarily to attract the dalag and bia. In fishing the latter bonbon two or more fishermen surround the nest with bamboo screens or *baclad*, remove the plants and sticks from the inclosure, and gradually reduce

the impounded area to a small live-well from which they can easily collect the fish by dip nets. The sigiw or talabog is fished by simply lifting one bundle at a time slowly out of the water and placing a bamboo basket or dip net under it to catch the shrimps.

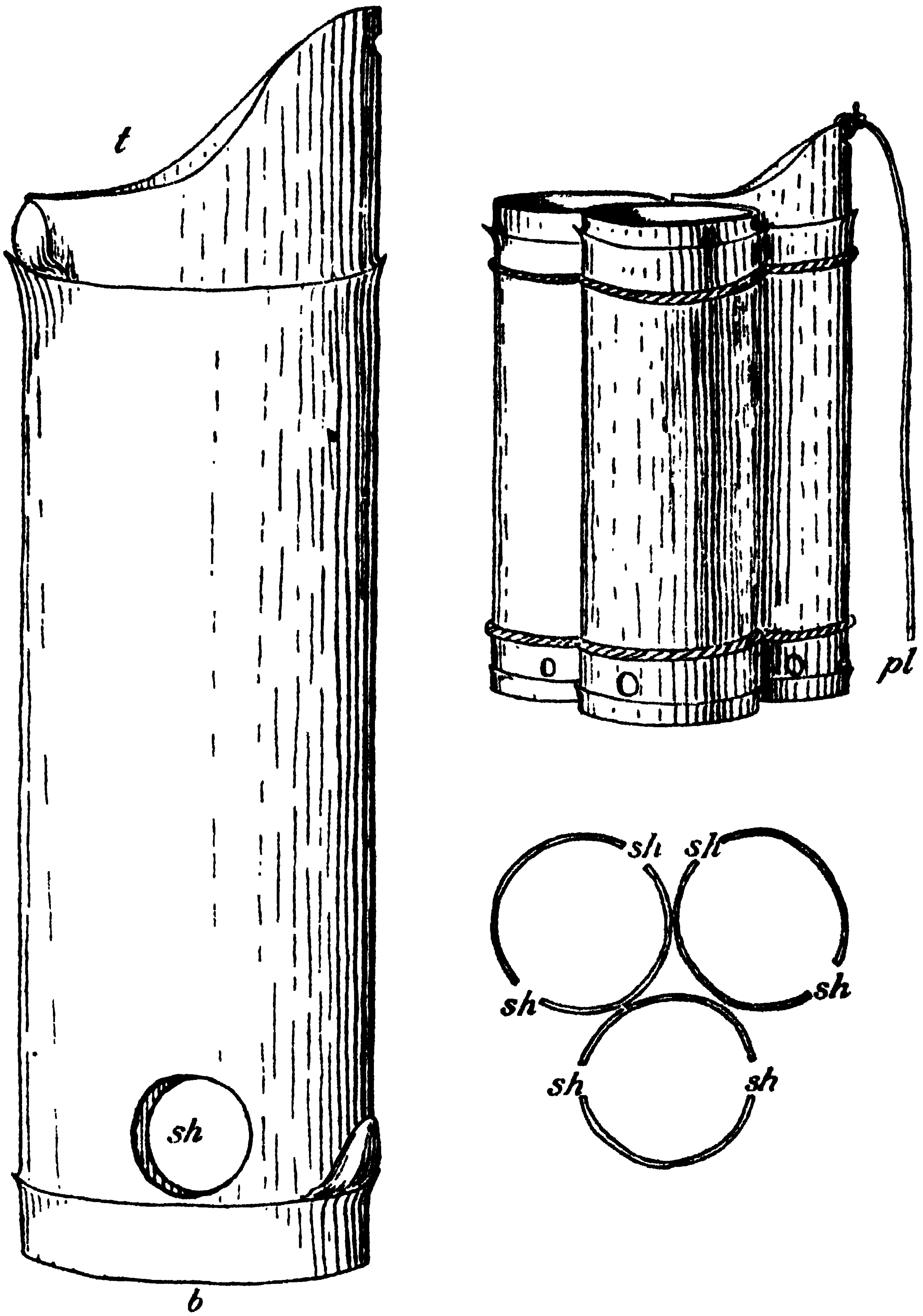

FIG. 8. Diagrammatic sketch of balumbong. b, bottom; t, top; pl, pull line; sh, side hole.

Balumbong.—The balumbong (fig. 8), a device to capture bakule or bia, consists simply of a bundle of three or four good-sized bamboo tubes each of which is about 40 centimeters in length and about 14 centimeters in culm diameter with two 3- to 4-centimeter holes bored through the walls along the diameter above the lower joint. One of the tubes is provided on the upper end with a short projection bearing a small hole for the attachment of the pull rope or line the free end of which is tied to a stake. By means of this rope the trap is raised or lowered to the bottom where it should rest in upright position. The balumbong is visited more or less regularly; the fisherman on a raft raises it slowly by the rope and before it comes completely out of the water carefully places a dip net under to catch the fish slipping out of the holes.

Patubog.—The patubog is a more or less winding ditch or canal, 2 to 3 meters long and 40 to 50 centimeters wide, dug on the shore to simulate a small natural creek, running usually at an angle from the shore line and ending blindly in a circular upper extremity. The water in the ditch is about 40 centimeters deep. Brush is placed near the entrance to attract the dalag, which instinctively enter the dugout. The entrance is closed with a bamboo screen before the canal is fished either with the bare hands or a dip net. Usually two ditches are constructed near each other with the blind terminals converging (fig. 9).

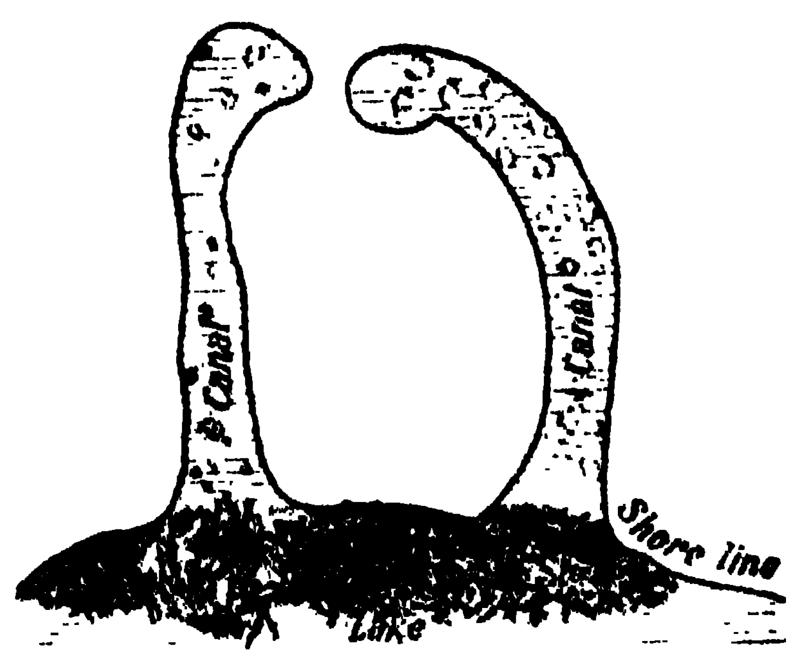

FIG. 9. Plan of patubog.

Kitang.—The kitang is a long line consisting of a main strand 50 to 100 meters long, with a number of short lines or snoods attached to it at certain intervals, each carrying a hook baited with an earthworm or shrimp to catch dalag, bia, and palos. The snoods are from 1 to 2 meters in length and are placed sufficiently far apart to prevent fouling. The line is set about half a meter below the surface, is anchored at each end by stone weights, and has a bamboo joint buoyed from one end to indicate the position of the line. The kitang is drawn in after an interval of about one hour or longer, depending on how abundant the fish are in the locality.

Kawil.—The kawil is a hook and line, with or without rod, baited with earthworm or shrimp to catch bia, palos, and dalag.

POSSIBLE CAUSES OF DEPLETION IN FISH SUPPLY

The three principal factors governing a decrease in the quantity of fish in a given area are natural environment, overfishing, and depletion of the supply of young fish by the catching of too many fry. In an area relatively so limited as Lake Sampaloc the influence of these factors cannot be overvalued. In this lake fishing is carried on very intensively, there is hardly any possibility of a continuous fresh supply from outside by way of the narrow outlet, and there has been no attempt at maintaining or increasing the natural supply through cultural and protective methods. An eventual alteration in the conditions maintaining life in the lake, which is likely to occur in such a region, may lead to the decline of some species or to their complete disappearance. In cases of overfishing of one, or a few species, or the fish fauna as a whole, each species will react in its own way to such a condition, and the reaction will depend upon the biology and upon the rate of propagation of that species. Intensive fishing will prevent the fish reaching full maturity, and as a consequence the bigger specimens will disappear first out of the catches. If this condition persists, the hauls will eventually consist of the smaller and the immature specimens, so that it will be only a matter of time until the supply of young fishes will be depleted if the practice of gathering the fry in unlimited quantities is continued.

The productivity of a lake or any limited area of water is certainly to be measured in terms of quantity and quality. That there has been a falling off in the quantity as well as in the quality of the fish in Lake Sampaloc is the consensus of opinion among the fishermen and the old residents of San Pablo. Of course, as has already been stated, it is impossible to substantiate this claim by statistics, since there are no records of the fisheries in previous years. Fluctuations always occur and are to be expected in every branch of a fishery. Apparently variations occur very frequently in Lake Sampaloc. In the absence of direct evidence, however, that is to say, as long as the average catch per gear per unit of time is unknown, and as long as statistics for each separate species are wanting, it would be impossible to come to any conclusion, particularly when considering such questions as overfishing and depletion of supply.

As far as could be determined the alleged decrease in the natural supply is due to the following apparent causes:

1. The lowering of the water level in the lake has resulted in the reduction of the fish supply.

2. The increasing demand incident to the increase in population of San Pablo has intensified fishing to such an extent that the capacity of the species to maintain themselves has been taxed to the limit.

3. The absence of protective measures has made it possible for the fishermen to exploit and exhaust the limited natural supply by continuous and indiscriminate fishing.

4. The selfish noncoöperative attitude of the fishermen in regard to conservation has greatly undermined the stability of the resources of the lake.

SUGGESTED REMEDIES

The following suggestions, if put into practice, might remedy the present situation of the fisheries:

1. Stocking the lake with dalag or other species. Transplanting young dalag into the lake is practicable and may prove profitable. The fry of this species are obtainable in large quantities from Laguna de Bay and other places during certain seasons of the year and are comparatively cheap. They stand transportation very well.

2. Regulatory fishing measures strictly enforced.

SUMMARY

1. The fisheries of Lake Sampaloc are of considerable economic importance, being the source of income of a large number of people in the region who are more or less dependent upon fishing in the lake for their livelihood.

2. The income from the fisheries is steadily decreasing as the supply of fish is reduced. The depletion is apparently due to overfishing through the unrestricted or indiscriminate practices of the fishermen.

3. The introduction of dalag or other species and adequate protective measures, properly enforced, might help ameliorate the condition of the fisheries.

ILLUSTRATIONS

Bird's-eye view of Lake Sampaloc from a point near the town of San Pablo.

PLATE 1.

1

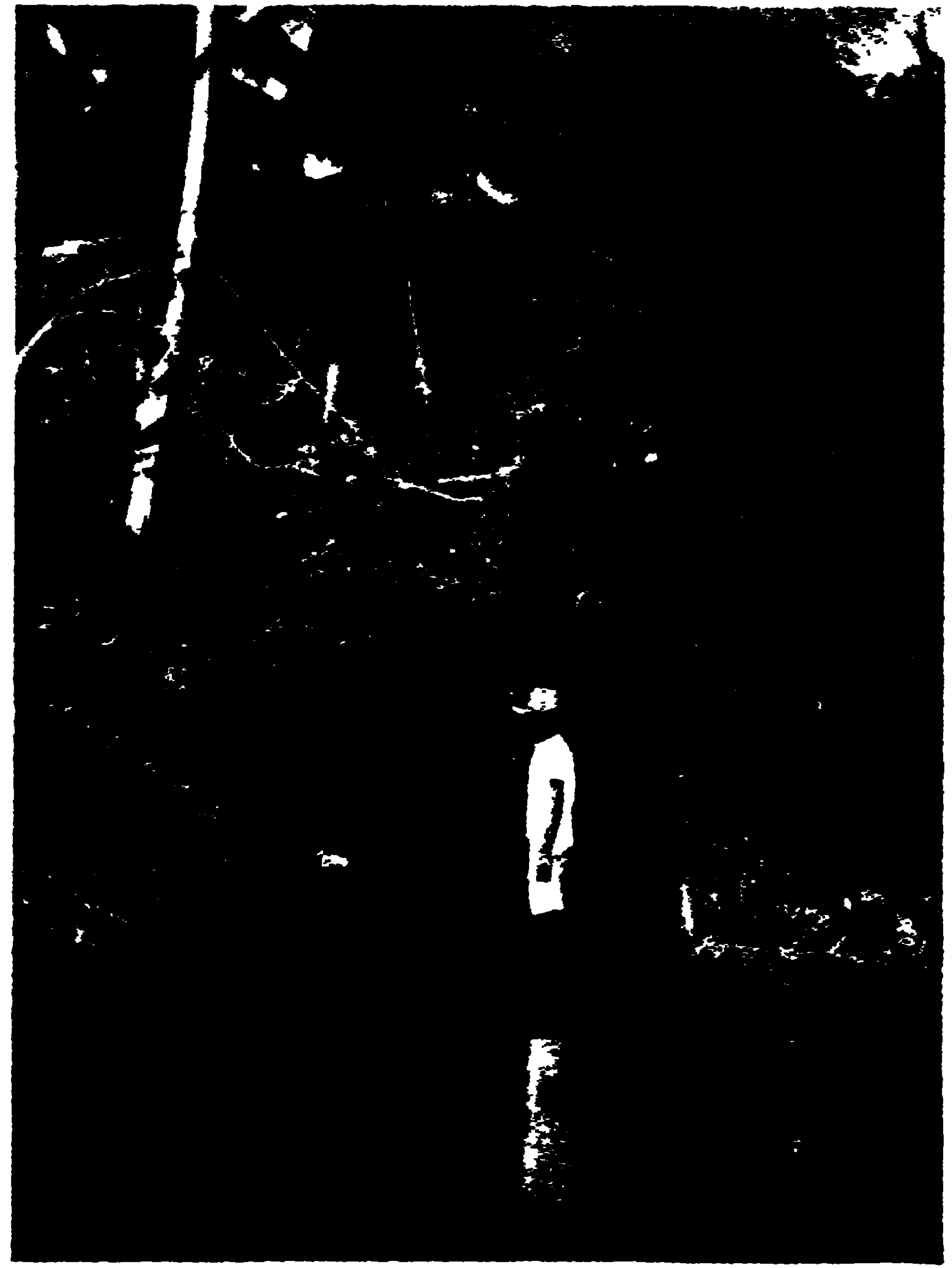

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PLATE 2.

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PLATE 3.

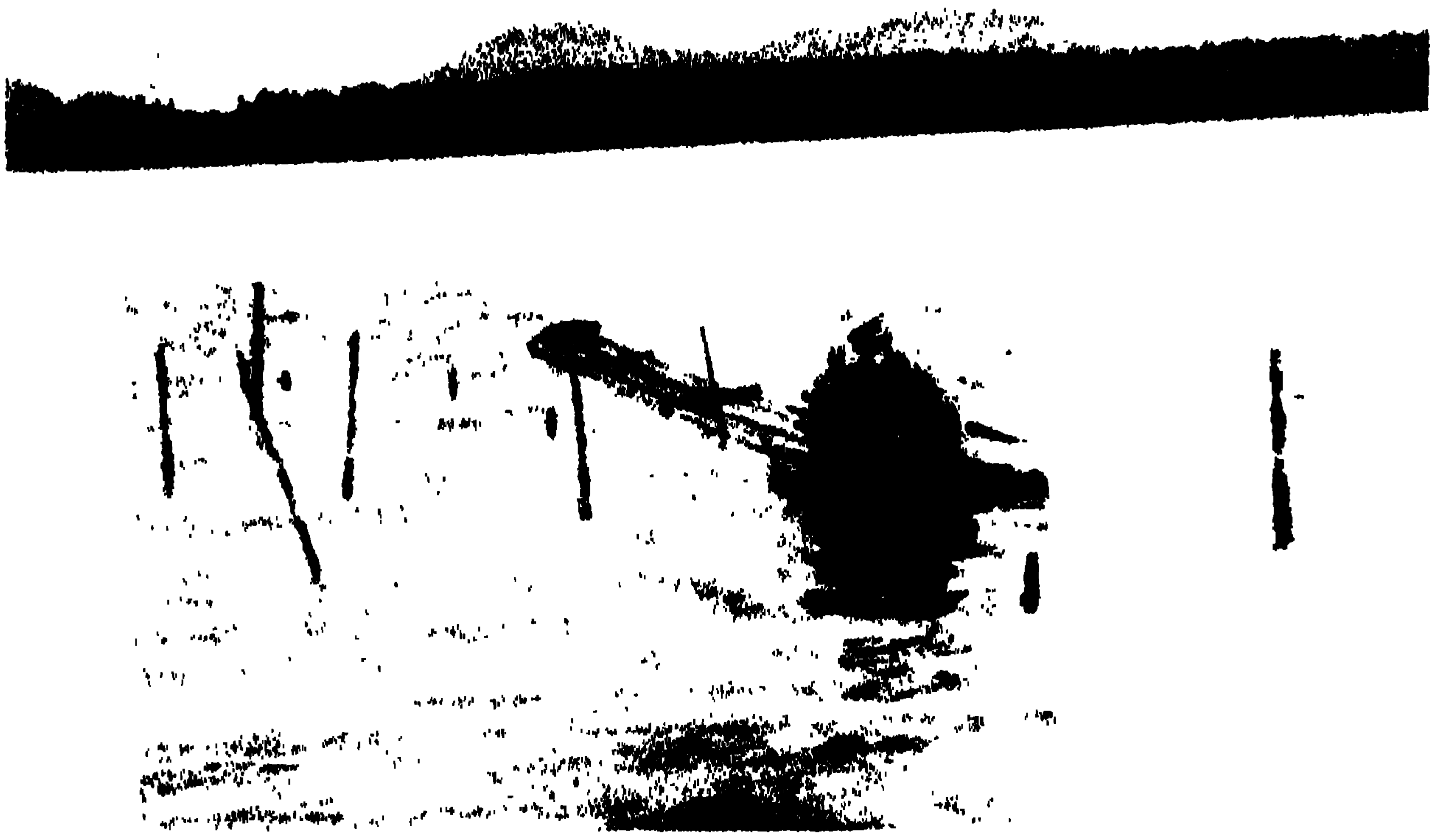

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PLATE 4.

FISHING APPLIANCES OF PANAY, NEGROS, AND CEBU

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Of the Division of Fisheries, Bureau of Science, Manila

FIFTEEN PLATES AND THIRTEEN TEXT FIGURES

INTRODUCTION

The present paper deals with the fishing appliances and equipment used along the coasts of Panay, Negros, and Cebu, and is based upon field notes gathered during successive surveys of the fisheries of these regions and upon examination of the models and natural-sized fishing gears now in the Bureau of Science collection.

In the course of investigation there arose the problem of terms to be adopted, due to a multiplicity of names in different places for what may be generally considered the same kind of appliance or equipment. However, the difference in names is not without reason in most cases, since upon close study it is revealed that there is always some distinguishing character, however slight, in the variously named devices. All available local names and technical terms were carefully considered and those most appropriate and distinctive were selected.

Among the types here described there are several that are also found in many other regions of the Philippine Archipelago. A good example is the cast net popularly known as *laya* in Visayan, *dala* in Tagalog, *lala* in Zambal, and *tabocol* in Ilocano, a net widely used throughout the Philippines, and in fact throughout the Indo-Pacific region. The *chinchorro* is another gear of general use in the Philippines. There are still others in the same category, which will be pointed out in the following discussions.

NETS

LAYA

Localities.—Throughout the western Visayan region and elsewhere.

Fishes caught.—All kinds of shore fishes, prawns, and crabs.

Description.—The laya is a conelike net that is cast and drawn, not set, and is about 3 meters high and 15 meters around

the heavily weighted base or bottom line (*bahayan*). The webbing (*puná*), always knit by hand, is of light, strong, and durable cotton twine—3-ply, No. 20 or 40—with a mesh (*matá*) of 18 millimeters, stretched. The net when distended is conical in form and shows sixteen equal triangular sections (*sinlâ*), the lacing of the lateral meshes of which, from the apex to the base, forms distinct radial lines (*hamitan*). The apical meshes are pursed by a stout cord to which is attached the recovering rope with a terminal loop that is held in one hand or slipped around the wrist; this rope is from 2 to 3 meters in length. The weights (*pamató*) are of lead especially molded in the form of the letter E; they are about 24 millimeters long, 14 millimeters wide, and 6 millimeters thick and weigh about 11 grams each; the three short projections are perforated lengthwise of the weight, and by means of these holes the sinkers are strung about 2 centimeters apart on the bottom line, each sinker being held in place by three peripheral meshes. All the peripheral meshes are clove-hitched to the lead rope, or bahayan.

Method of use.—The laya may be cast from a river bank or from a dugout or raft, but it is generally seen thrown by a fisherman in waist-deep water. A right-handed fisherman about to make a cast prepares the net in the following manner: First, he slips the loop of the retrieving line around his right wrist and holds the upper part of the net in folds over his right arm; second, he takes an outer section of the net just above the leads and slings it around the curve of his arm up to the shoulder; third, he holds a second portion in the right hand and a third section in the left. Thus, the net is held in a pleated or fanlike arrangement. Then with a deft half swing of the arm and body to gain momentum the fisherman whirls the net forward so that the weights spread the lower margin in a circle; the heavily loaded border, as soon as it hits the water, sinks and drags the netting downward in the form of a hollow cone entrapping the fish within its scope. The fisherman waits until the lower edge has reached the bottom when he slowly and carefully pulls in the hauling rope until he grasps the apex; as he draws the net towards him by the apex, the cone flattens, its sides collapsing upon themselves in pleats, further insuring the confinement of the fish within. He carries the net to the shore where he removes the catch. After cleaning the net of any rubbish, he rearranges the folds over his arm and is again ready to prepare the net for casting.

HUDHUD

Localities.—Throughout the Visayan region and elsewhere.

Fishes caught.—All kinds of small fishes, especially gobies (*gamia, tabios*), shrimps or prawns, and crabs.

Description.—The *hudhud* (fig. 1) is similar to the *sakag* of the Tagalog and the *sayursur* of the Zambal. It is a flattened conical bag of fine-meshed sinamay, or salap netting (cloth woven from the fiber of Manila hemp, or abacá, *Musa textilis* Née), with a large triangular mouth the sides of which are rigged on two bamboo cross-poles (*kayauan*) that move on a pivot. The net is made in eight sections or pieces (sinlâ) and is about 3 meters across the lower edge of the mouth and 5.5 meters from this edge to the end of the pocket (*púyo*). The three borders

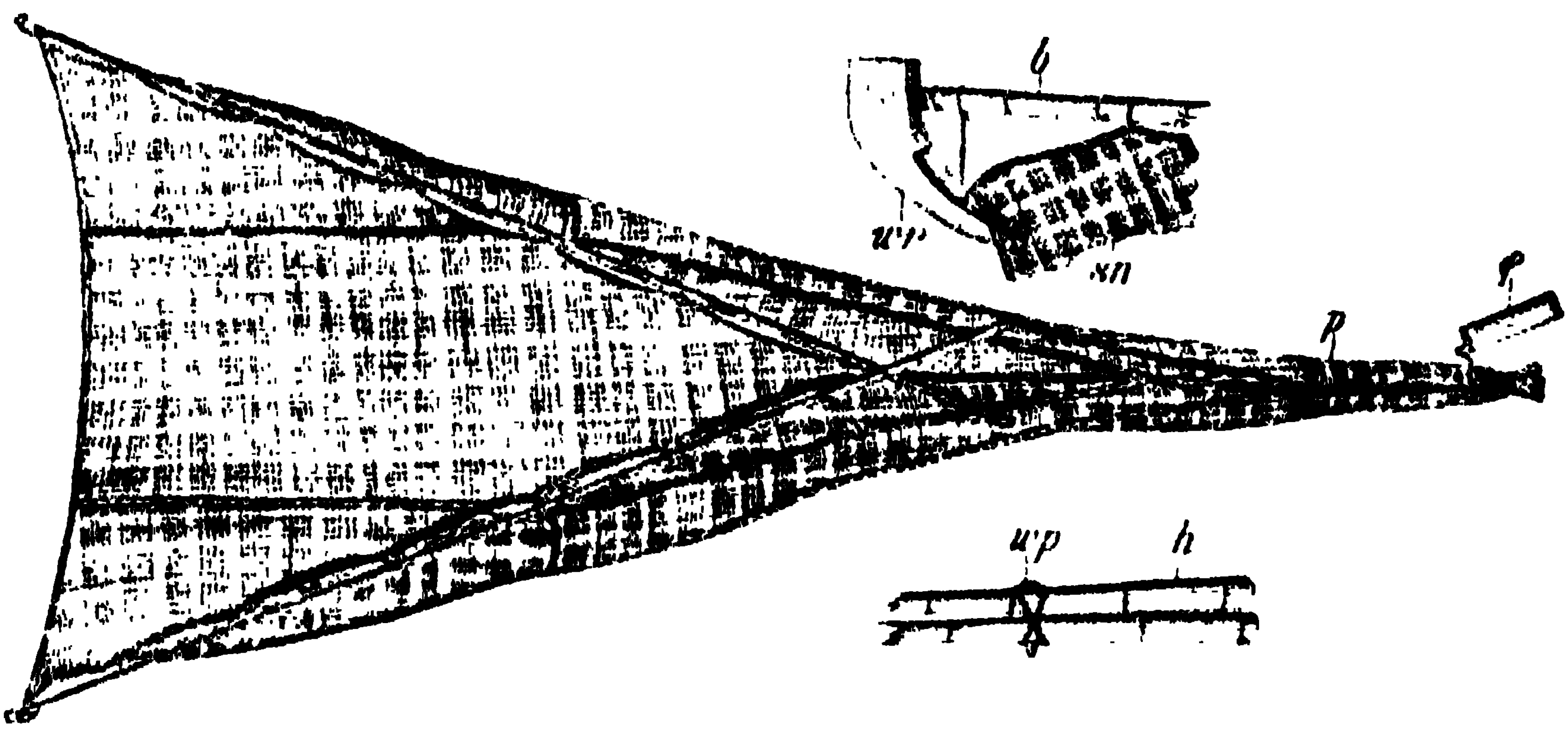

FIG. 1. Diagrammatic sketch of hudhud; *b*, bamboo crosspiece (kayauan); *f*, float (patao); *h*, handle (kalaptan); *p*, pocket (püyo); *sn*, salap netting; *wp*, wooden peg (tuuung); *wr*, wooden runner (sapatos).

of the mouth are hemmed and strengthened by a marginal cord (*halughug*) and are attached to the long arms of the cross-pieces so that the apex formed by the two opposite margins coincides with the intersection of the cross-poles. The poles are each about 4.5 meters long and 4 millimeters in greatest diameter and intersect at a point about half a meter from the upper extremity. A wooden nail or peg holds the poles at the crossing and allows them to be worked in a scissorslike manner. The short sections from the pivot are the handles. The far end of each pole is equipped with a runner (*sapatos*), which is an adz-shaped affair made of a cylindrical piece of wood, about 40 centimeters long; the vertical portion of the runner is joined at right angles to the pole by means of a socket and the curved

lower extension is keeled on the upper surface; the keel is perforated crosswise, through which the cord from the lower corner of the mouth of the net is passed before it is fastened to the pole. The pocket is tied at the end by a stout twine and is provided with a bamboo float.

Method of use.—The hudhud is used as a scoop net or dip net in shallow water along muddy and sandy bottoms. The fisherman wades to waist depth, lowers the net in position, and holds the handles as he pushes the implement on the runners before him; he lifts the net every so often to deposit the catch into the extreme end of the pocket. When preparing to lift the hudhud the operator places himself between the handles so that the latter rest against his waist or hips; then he grasps the poles in front of him and raises them by sheer force of the arms and the backward movement of his body until the poles are brought up to an angle of about 35 degrees; he shakes the net to allow the catch to fall into the bag; then he lowers the poles to continue fishing or to collect the catch, which is removed by untying the purse string and emptying the contents of the pocket into a live basket. This receptacle is towed by the fisherman with a twine tied around his waist.

PATIGBI

Localities.—Sicaba, Cadiz, Escalante, Occidental Negros; Bantayan, Cebu.

Fishes caught.—All kinds of small shore fishes, particularly mullet (*gusao*), anchovies (*gurayan*), shrimps or prawns, and swimming crabs.

Description.—The *patigbi* (fig. 2) consists of two units; namely, a shallow bag net, about 8 meters at the bottom line (*sadsaran*), 7.5 meters long, and 15 meters around the float rope, and a "driver" (*sagiwsiw* or *labay*), which is a stout rope 40 to 80 meters long bearing at certain intervals elongated pieces of coconut husk and small bamboo floats. The net, entirely knit by hand, is of No. 20 and 40 cotton threads with a uniform mesh of 14 millimeters, stretched; the larger, or No. 20, thread is used in the narrow border around the mouth of the bag; this border is five meshes in depth and has a single selvage through which the head or float rope and bottom lines are laced. The floats (*patao*) of light wood, usually *hanagdong* (*Trema amboinensis* Willd.), are cylindrical and measure about 6 centimeters in length and 4.5 centimeters in greatest diameter;

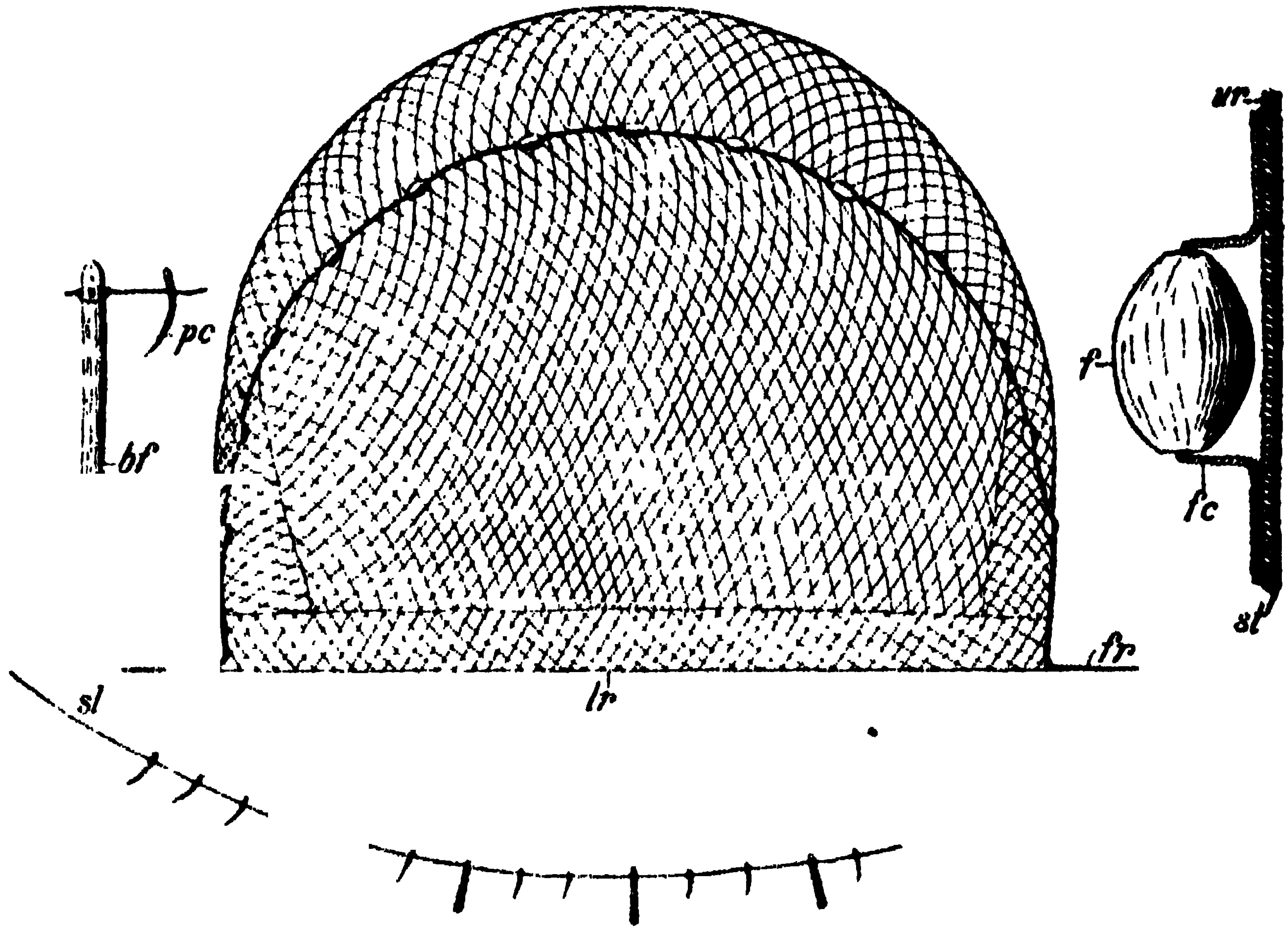

Fig. 2. Diagrammatic sketch of patigbi; *f*, float (patao); *bf*, bamboo float (patao); *fc*, float cord; *fr*, foot rope (lapacan); *lr*, lower rope; *pc*, piece of coconut husk; *sl*, scare line (sagiwsiw, labay or tabúg); *st*, seizing twine; *ur*, upper rope.

they are perforated lengthwise, and are strung 17 centimeters apart on a smaller rope (halughug) which is seized at regular intervals to the headrope by a light but strong cotton twine. The float rope is extended about 2 meters from the lower corner of the mouth; this extension serves as the footrope (*lapacan*), which is held on the bottom with the feet of the fisherman. The labay, or scare line, carries a number of elongated pieces of coconut husk 15 to 20 centimeters long and a few small bamboo floats 21 to 30 centimeters in length, which are tied at one end to the line about 25 centimeters apart.

Method of use.—The patigbi is operated in shallow water along gradually sloping shores. Four men working from one dugout form the complement for one net. When setting the net one man stands at either side holding the float line in hand and treading the footrope into the sandy or muddy bottom with the feet. The other two men carrying the scare line (labay) wade in waist-deep water and lay it out in a semicircle in front of the net and then draw it in rapidly, shortening it as they approach the distended bag. The line thus drawn in with the pieces of coconut and the bamboo floats produces a peculiar swishing sound, which drives the fish towards the net. As soon

as the labay reaches the bag, the net tenders immediately pull up the bottom until it lies along the float rope. The dugout, which has been anchored near-by, is now brought alongside the net by one of the line carriers. The net is gathered in and placed partly aboard the dugout to facilitate the removal of the catch from the bag.

SAHID

Localities.—Cadiz, Escalante, Occidental Negros; Bantayan, Cebu.

Fishes caught.—All kinds of small shore fishes as well as prawns and swimming crabs.

Description.—The *sahid* is a cotton drag net about 7 meters long and 1.5 meters wide at the mouth which extends the whole length, and is characterized by the use of wooden struts, or spreaders (*tokotoko*), crossing the net vertically and attached top and bottom to two marginal ropes for the purpose of keeping the mouth distended. Specifically, this device is made by doubling a rectangular piece of cotton netting about 3.5 meters wide lengthwise upon itself and connecting the two edges, forming the mouth by means of seven wooden struts slightly over 2 meters long set 1 meter apart. Since the spreaders are much shorter than the width of the netting they cause a bagginess in the entire net. The netting, hand knit and made in a number of sections (*lambitan* or *tinapac*), is of No. 20 cotton string, except in the narrow border (*sadsaran*) along the upper and lower sides where the webbing is of a larger twine; this border has a single selvage laced to a strong hanging line (*guput*), which is clove-hitched at regular intervals around the marginal ropes. The whole of the net has a uniform mesh of 14 millimeters, stretched. The ends of the net are loosely laced to a short hanging line (halughug) and are thus somewhat pursed. From each end strut the marginal ropes are extended about a meter to form the bridle (barabara) of each brail (*pahuran*), which is slightly shorter but much larger than the strut and has a hole near each end through which the bridle rope is passed and knotted at the terminal.

Method of use.—The sahid is operated as a dragnet in seine fashion by two men wading out from the shore. Both carry the net equally divided between them, the struts threaded on one arm. They wade out to waist or breast depth, and then turning landwards spread the net, diverging as they do so; holding the brails they drag the net after them and gradually

close in as they approach the beach. Upon reaching the shore the men haul in the ends until the net is brought to the beach where the catch is removed. After the net is cleaned of all rubbish and properly arranged the fishermen are again ready to trawl. The operation is repeated as many times as possible throughout the day; each operation generally takes about half an hour. Fishing with this net is done more frequently during the period from the rise of the tide to the slack than during the low tide. The sahid is used during the day and at night.

SURAMBAO

Localities.—Along the coasts of Negros, Bantayan, and Cebu.

Fishes caught.—All kinds of small fishes as well as prawns and crabs.

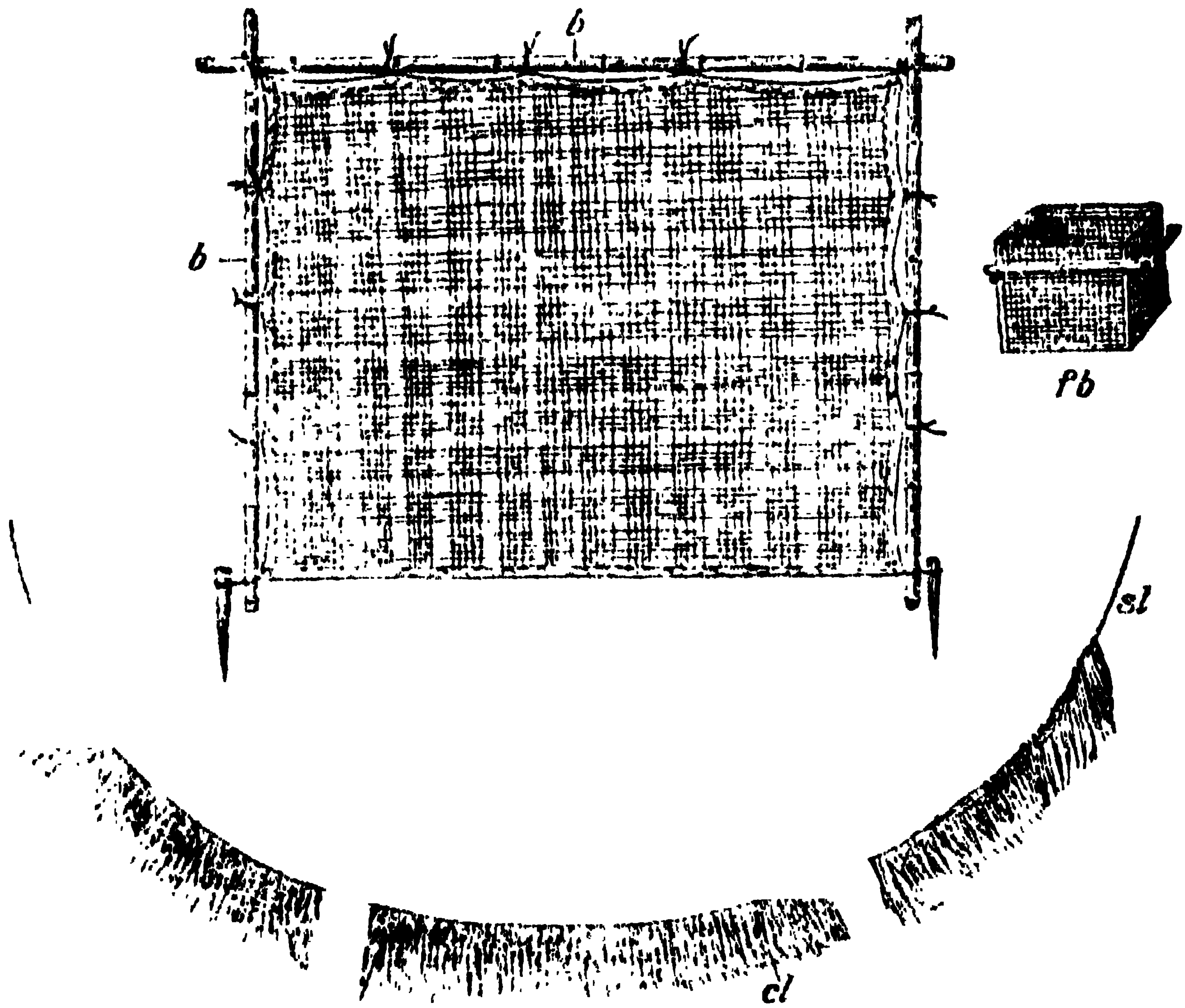

FIG. 3. Diagrammatic sketch of surambao: *b*, bamboo frame; *cl*, coco-palm leaves (lukay); *fb*, fish box; *sl*, scare line (tabúg or lukay).

Description.—The *surambao* (fig. 3) is a rectangular set net of fine-meshed salap or sinamay used as a barricade and scoop in conjunction with a scare rope or line (*lukay* or *tabúg*) carrying streamers of fresh coco-palm leaves. The net made in

sections is usually 5 meters long and 3 meters wide; its upper margin and two lateral borders are attached to bamboo poles, which are slightly longer than the sides of the net. The scare rope, or driver, is from 30 to 50 meters long; attached to this in close order are fresh coco-palm leaves about 40 centimeters long split into shreds. The surambao carries a fish car, or live box, which consists of a large bamboo basket or a box of wire netting provided with bamboo floats.

Method of use.—This contrivance is used in shallow water along the shores and sand bars. It is operated by from four to six men; two carry and set the net, and the rest take the scare rope or string of leaves in a dugout. The net is first set at a favorable location in water a little over a meter in depth. The lower ends of the vertical poles are tied to wooden stakes, and two men hold the net in a position slightly inclined backwards. The inclination allows the netting to sag and form into a sort of shallow bag. The rest of the crew take the scare line out from the shore in a banca and spread it in a semicircle. In laying out, one end of the line is first left in the care of one or two men in comparatively shallow water not very far from the net; as soon as the other end has reached the desired spot and the "scarer" has assumed a half-moon shape the two ends are pulled in towards the net, the men shortening the line as they approach the shallows until they come close to the side of the slanting set bag. The hauling is continued until the fish come to the net, when it is immediately lifted. The catch is transferred to the livebox.

KAYAGKAG

Localities.—Sicaba, Cadiz, Escalante, Occidental Negros; Bantayan, Cebu.

Fishes caught.—All kinds of surface fishes, such as billfish (*balanban, bigiw*), flying fish (*San Vicente, pakpakan*), and other species.

Description.—The *kayagkag* (fig. 4), also called *anod* in many localities, is a light cotton drift gill net of 35-millimeter mesh, from 5 to 15 meters long and 1 to 3 meters deep. The netting, entirely hand knit, is of No. 20 cotton twine. The head, or hanging, rope carries at regular intervals a number of subcylindrical wooden floats, which are not strung around the line but attached to it by separate short cords. There is no bottom rope, and sinkers are not used. Beyond each end of the

net the headrope is prolonged 2 to 3 meters to which a buoy is usually attached. Upon the headrope the upper marginal meshes of the net run freely to facilitate the entanglement of the fish that strike the net. The net is generally tanned brown or blue.

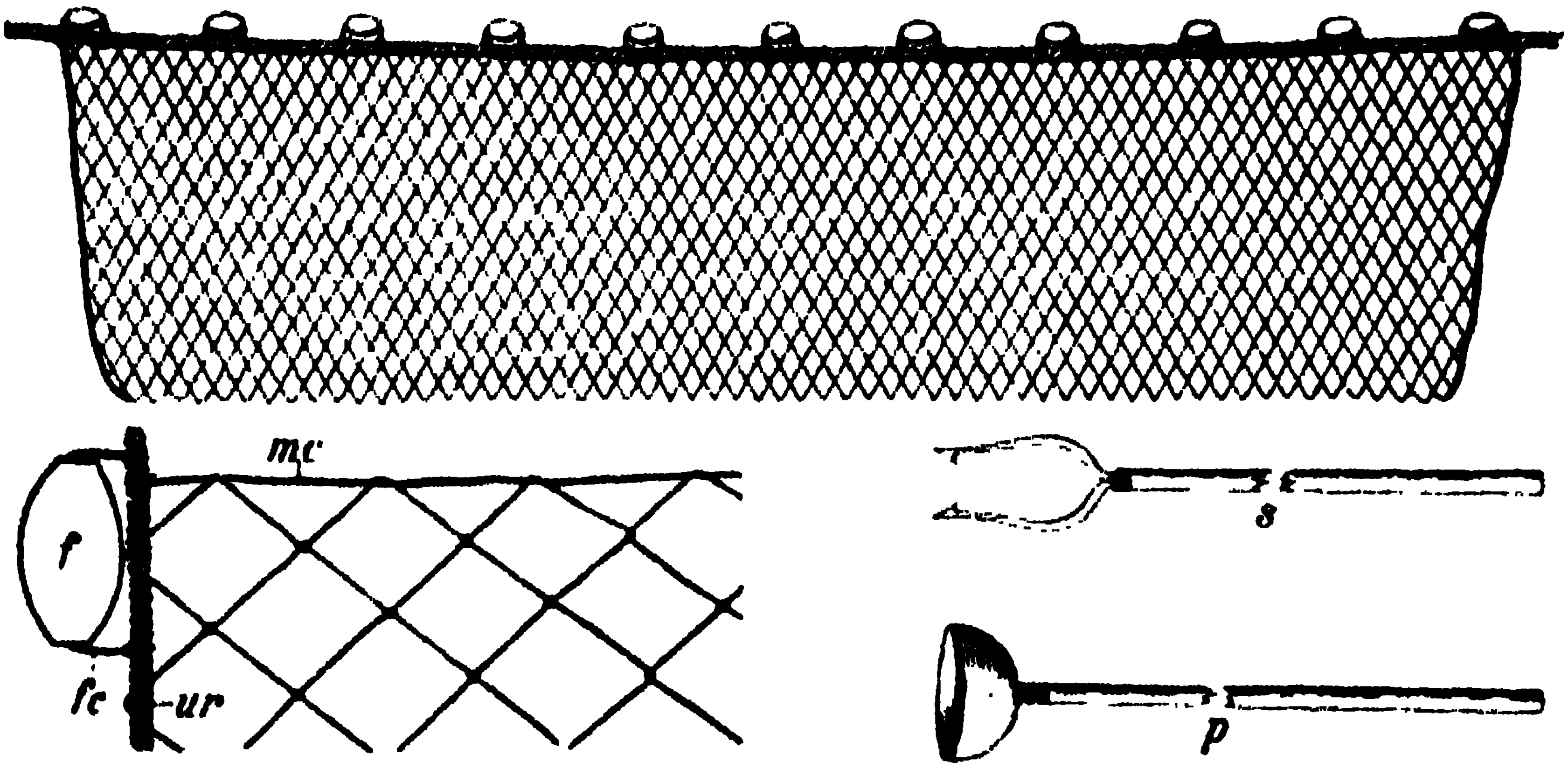

FIG. 4. Diagrammatic sketch of kayagkag, or anod; *f*, float (patao); *s*, spear (sibat); *p*, plunger (tumbuk); *fc*, float cord; *mc*, marginal cord (halughug); *ur*, upper rope.

Method of use.—Two or three men in a dugout take the net to a favorable locality in shallow water close inshore or in the deeper water of the open sea where the net is shot across the current and allowed to drift with the tide. The fishermen in the meantime endeavor to drive the fish against the net by splashing the water with a plunger, or *tumbuk* (fig. 4, *p*). The net is hauled in every one or two hours depending upon how abundant the fish are in the locality. The large-sized fish that get tangled in the folds of the net are removed by means of a two-pronged spear, the *sibat* (fig. 4, *s*), while the net is still in the water, so as to avoid possible tearing of the web and to insure the capture of the creatures. The kayagkag is used usually on dark nights, but it is employed in the daytime also. When used at night, the buoy carries a torch to attract the fish. Sometimes the net is baited with dead fish.

PUKOT

Locality.—Sicaba, Cadiz, Escalante, San Carlos, Occidental Negros; Bantayan, Barili, Cebu.

Fishes caught.—Primarily herring or sardines locally known as *tamban, hauhaul, dughanan, tabagak, tuloy, balantiong, mudyas, tagnipis, malangsi.*

Description.—The *pukot* (fig. 5) is also called *salibut* in Iloilo and Negros and *pukot sa mudgas* in Cebu. It is a circular gill net 70 to 160 meters long and 6 to 10 meters wide, hung measurement, with meshes of from 25 to 35 millimeters, stretched. All parts of the net are of the same depth; that is, the wings and the bunt, or middle portion, have the same depth. The webbing, entirely hand knit, is of Nos. 20 and 40 cotton twine; the larger, or No. 20, thread is used in the upper and lower borders, which are about 10 centimeters wide each; the webbing of these borders is slightly larger than that of the

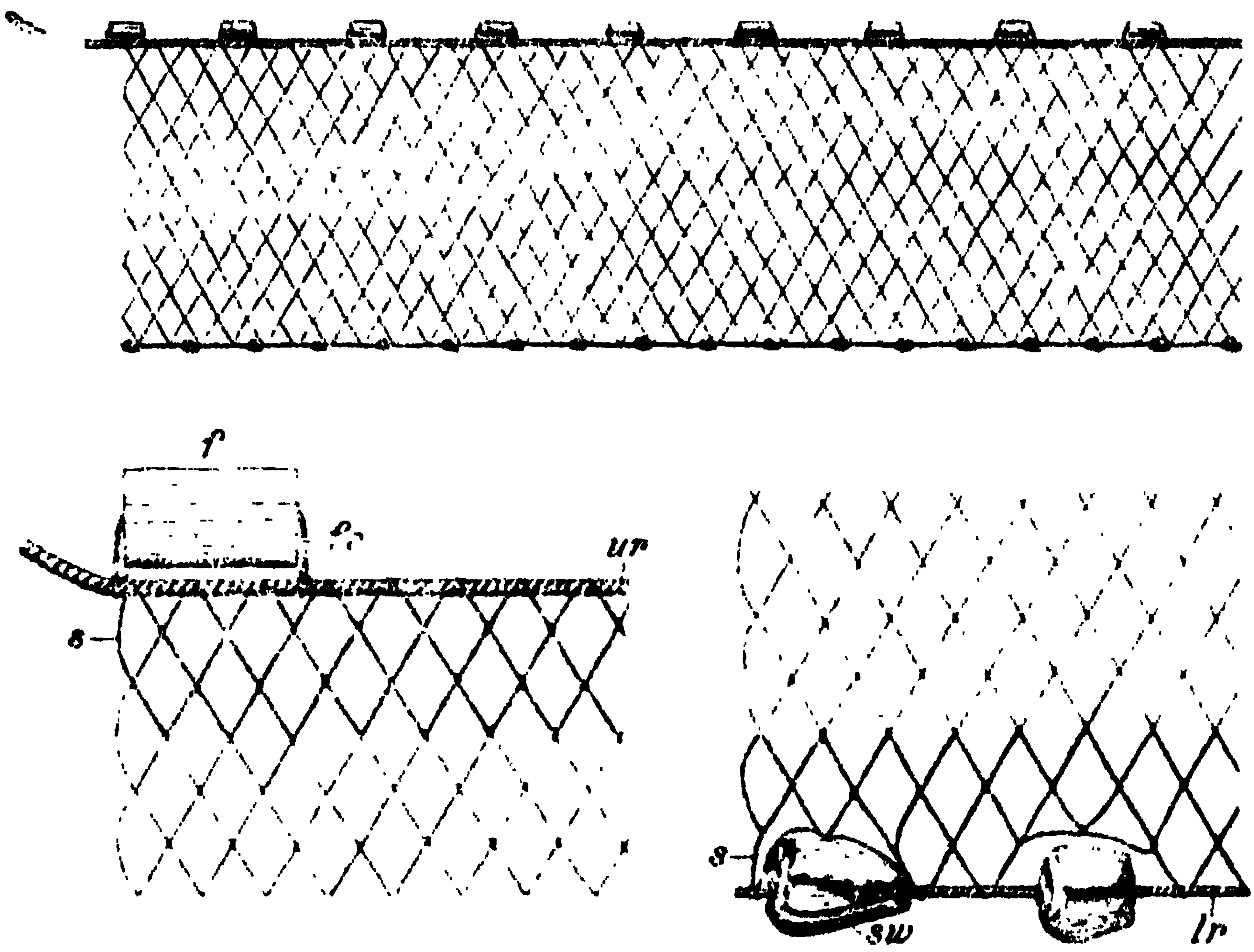

FIG. 5. Diagrammatic sketch of pukot: *f*, float (patao); *s*, single selvage (sadaaran); *fc*, float cord; *lr*, lower rope; *sw*, shell weight; *ur*, upper rope.

main net, and the selvage is single. The head or float rope and the foot or lead line are laced through the marginal meshes of each border; these meshes run freely upon the lines to facilitate the tangling of the larger fishes in the folds when they strike the net. Cylindrical floats of hanagdong or *dapdap* (*Erythrina variegata* var. *orientalis* Merrill) are attached to the headrope at certain intervals by separate cords or rattan, and weights of lead or strombus shells, *liswi* or *sikad* (*Strombus luhuanus* Linn.) are strung around the bottom rope. There are sufficient floats to hold the upper margin of the net on the surface,

and there are enough weights to keep the net vertical in the water. The net is usually tanned blue with *tagum* (*Indigofera suffruticosa* Mill.).

Method of use.—Three or four men working from a dugout form the complement for one pukot. The net is taken out and spread around a school of sardines. One wing provided with a buoy is dropped first and then the rest of the net is paid out until the buoy is regained. As soon as the two wings converge the men beat the water inside the circle with paddles and poles and make all sorts of noise in order to scare and drive the fish to the net. The average-sized sardines for which the net is intended are gilled, and those that are too large to be caught in this way are entangled in the folds. A net 6 meters wide is usually operated in waters 8 meters deep or deeper, so that the footrope never touches the bottom. The hauling is always done inboard, and the catch is removed by shaking and picking. This method of fishing is carried on both during the day and at night.

CHINCHORRO

Localities.—All around the coasts of Iloilo, Negros, Cebu, and elsewhere.

Fishes caught.—All kinds of small shore fishes as well as shrimps, prawns, and crabs.

Description.—The *chinchorro* (Plate 9, fig. 2), also called *bitana* or *baling*, is one of the commonest and undoubtedly one of the most efficient fishing gears in the Visayan region. It is a seine of finely woven abacá cloth and consists of a comparatively long conical pocket flanked by two long tapered wings of equal size. This net varies a great deal in measurements and is made in several sections or pieces (sinlà) sewn together along the sides with abacá twine; the hem is strengthened by a marginal cord to which is fastened a narrow strip or border of stout abacá webbing of 6-centimeter mesh, stretched; this border has a single selvage that is hung from a cord which is in turn seized at regular intervals to the head and bottom ropes. A wooden strut, or spreader, slightly shorter than the width of the wings at either extremity, is attached top and bottom to the short extensions of the marginal ropes to prevent the wings from collapsing when hauled in; each spreader carries a bridle (barabara) to which is tied a long warp or pull rope (*butuñgun*). The floats of hanagdong or dapdap or the fruit of

bolobitoon [*Barringtonia asiatica* (Linn.) Kurz.] along the headrope are evenly distributed, being secured by separate cords about 20 centimeters apart. The wooden floats are cylindrical. Strung around the footrope at regular intervals are shell weights, liswi or sikad, in sufficient numbers to keep the net vertical in the water. A stout cord (*bugkus*) is tied around the end of the bag. The net is usually tanned brown in a concoction of mangrove bark. The chinchorro is provided with a bamboo platform or carrier (*papag* or *langkapan*) upon which it is carefully laid to be stored or to be taken out for use.

Method of use.—The bamboo platform with the carefully piled net is carried by the fishermen and placed near the stern of a dugout or banca. The crew, numbering from six to ten men, depending upon the size of the net, rows or paddles the banca to some distance from the shore. When catching a school of fish located in shallow water close to the shore, the operation of the net is similar to the way the tabug of the surambao is worked, and the haul is made to the beach. The pull rope of one wing is left in the care of two or more men at a point where the water is about waist deep. The boat is steered around, while the rest of the net is paid out to encircle the fish.

In order to make sure that the pull rope on the boat will reach the desired spot, the boat is directed shoreward immediately after the bag is thrown out. When the laying out is completed the net lies in the shape of a half-moon. All the men "abandon the banca" to help in the hauling. Two or three fishermen busy themselves with "foot work" so as to make the lead line follow the bottom of the shore to preclude the possible escape of fish. As the net is hauled in, the slack is thrown behind the pullers. The hauling is continued until the fish are bagged. The catch is removed with dip nets or baskets or by emptying the bag into the banca.

When the laying out of the net is made in deep water, far from the shore, the round haul is employed to impound the school of fish, and hauling is done inboard. As soon as the ends of the wings converge they are taken together on board the banca and hauled in simultaneously at practically the same rate. Hauling continues until the bag is reached. If the catch is large the fish are brailed out of the pocket with dip nets; if small, the whole bag is lifted out of the water and its contents emptied into the banca. The chinchorro is used during the day and at night.

SAPIAO

Localities.—Throughout the western Visayan region, particularly in Estancia, Iloilo, along the coasts of Capiz, and around the northern waters of Occidental Negros.

Fishes caught.—Primarily herring (tamban, tuloy, tabagak, haulhaul), chub mackerel (*bulao, guma-a*), and other moderate-sized species that run in schools.

Description.—The *sapiao* is a familiar round-haul seine of stout cotton twine, generally measuring from 25 to 45 meters long and from 18 to 22 meters deep. The webbing, formerly entirely knit by hand but now made up of a number of sections of manufactured netting, has a stretched mesh of about 4 centimeters at the bunt and about 6 centimeters at the wings. The netting is bordered along the upper and lower margins by a webbing of coarser twine and larger mesh. The upper selvage is hung from a stout abacá rope, which is, in turn, seized at regular intervals to a strong upper rope carrying wooden cylindrical floats a few centimeters apart. The lower selvage is similarly attached to a stout bottom line with a sufficient number of molded beadlike lead sinkers strung at convenient intervals to hold the net perpendicularly in the water.

Method of use.—The sapiao is operated from a good-sized dugout, and on account of its small mesh requires a crew of from twenty to forty men to haul it. The apparatus is taken out to sea and as soon as a school of sardines or chub mackerels is located the boat maneuvers until an advantageous position is attained for making a haul. One wing of the net to which a buoy (*patao*) is attached is dropped and the rest of the seine is paid out while the banca steers around to the buoy. The pull ropes are drawn and the bottom is pulled up rapidly in order to prevent the possible escape of the fish by diving or sounding. Hauling continues until the catch is impounded at the bunt. The fish are gradually transferred to the banca with dip nets. The sapiao is used in the daytime or at night, but generally after dark when the movement of the school of fish can be more readily noticed.

PADUYAN

Localities.—Cadiz, Escalante, Occidental Negros; Bantayan, Cebu.

Fishes caught.—All the common shore fishes; such as, herring or sardines (tamban, tuloy, haulhaul, *lilang*), whiting (*aso-os*), croaker (*abo*), silversides (*gunô, dagubdub*), slip-mouths (*sap-*

sap, lawayan), and mackerel (bulao, guma-a), as well as prawns and crabs.

Description.—The *paduyan* or *kabiao* is a cotton bag net with a wide square mouth usually 10 to 20 meters on each side. The bag is made up of rectangular sections of netting interlaced along their sides. The netting, entirely hand knit, is of No. 20 cotton twine; the mesh decreases in size from the borders to the bunt or central portion; the borders, which are attached to the four marginal ropes and are made of thicker twine, are about 30 centimeters wide and of from 40- to 50-millimeter mesh, stretched; a section of netting next to the borders inwards is of about 30-millimeter mesh, stretched; and the rest of the netting constituting the bunt is of 25-millimeter mesh, stretched. The marginal ropes along the mouth are of abacá, about 20 millimeters in diameter; the side that is uppermost when the net is in operation is attached to a long bamboo pole, which serves as a float; the side opposite to the float carries a number of lead or stone sinkers at regular intervals and four pull ropes several meters long, which are attached to the two corners and middle of the side.

Method of use.—This net is operated by from four to six men in shallow water close to the shore during fair weather. One large banca and a one-man dugout are used. The latter is for the watcher who is equipped with a water glass (a bucket with a glass bottom). This is to aid him in seeing the fish several meters below the surface, when the water is clear and more or less still; that is, during calm days. To set the net in position the bamboo float is first dropped and anchored at each end, and the rest of the net is paid out as the banca is moved as far as the pull ropes will permit. By means of the pull ropes the net is kept in any desired position in the water; that is, perpendicular or slanting, usually the latter. When the watcher in a small dugout along the float signals for a haul, his companions draw in the pull ropes carefully until the net is converted into a large suspended bag or "hammock" (*duyan*) from which similarity the apparatus derives its vernacular name. The fish are caught as if they were scooped up by a large dip net in a single wide sweep. While the net is gathered in the fish are transferred into the banca by means of small dip nets. Finally, the float with its anchors is lifted and the outfit moves to another fishing ground.

LAWAG

Localities.—Estancia, Iloilo; Cadiz, Occidental Negros.

Fishes caught.—Particularly fishes that run in schools; such as, herring (tamban, tuloy, *tabagak,* haulhaul), slip mouths (sapsap, lawayan, *bagulan*), croaker (abo), chub mackerel (guma-a, bulao), and such important species as pampano (*lison, badlun, mañgudlong* and tuna (*tuliñgan*).

Description.—The *lawag* is a deep-water cotton net, similar to the preceding in many respects, generally square, each side measuring from 20 to 35 meters. The netting, which is of No. 20 cotton twine, is attached on four sides to a stout rope. One side carries a number of wooden floats and the other, opposite to it, bears lead or stone weights. To each of the other two sides are attached six or eight pull ropes, each 50 or more meters in length. The net has three sections of webbing of different meshes. The section along the border, occupying about one-fourth the area of the square has a square or bar mesh of about 20 millimeters; the next section, one-half the square in area, has a bar mesh of 10 millimeters; and the central portion or bunt has a very fine square mesh of only about 5 millimeters. The lawag is also known as *sapiao con luces,* a term generally given to any seine operated with the use of powerful artificial lights or lamps.

Method of use.—Two good-sized bancas and two or more small dugouts are necessary in the operation of the lawag. Each of the small boats carries a kerosene or alcohol lamp of about 300 candle power for the purpose of attracting fish. These small boats go out ahead of the large bancas, and as soon as they locate a school the lamps are turned on full power. The large bancas come near and then the net is spread in an arc between them; the pull ropes from each banca are slightly drawn in so that the net will assume a slanting position in the water. When the signal is given that the gear is set, the lamp-carrying dugouts move towards the center of the net, thereby luring and leading the victims into the trap; the small boats maneuver to get out of the way when the net is hauled; at the proper moment the pull ropes are worked until the net is converted into a large suspended bag between the two bancas; the sides of the net are hauled in and the fish removed with dip nets; finally, the bunt, containing the rest of the catch, is lifted into the banca. Capturing fish by the use of a powerful light to attract them is

commonly known as "jacking." This is considered more or less destructive, and in Estancia, Iloilo, and Samar, particularly, its practice is being discouraged.

KUBKUB PATIYOY

Localities.—Along the northern coast of Occidental Negros, and around Bantayan, Cebu.

Fishes caught.—Chub mackerel (guma-a, bulao), pampano (lison, badlun, *mamsâ*), and other species that run in schools.

Description.—The *kubkub patiyoy* is an impounding cotton net, about 250 meters long, with a bunt, or middle section, 30 meters deep flanked by two long tapered wings. The netting, hand knit or machine-made, is of strong 3-ply cotton twine; the mesh at the wings is 8.5 centimeters, stretched, and in the bunt 5.5 centimeters, stretched. A strong abacá rope, 10 millimeters in diameter, is laced through the marginal meshes of the net along the upper and lower edges. The upper rope is seized at regular intervals to the head or float rope which is of the same material and size, and the lower rope is similarly attached to the lead or bottom line. The headrope is very much longer than the bottom rope. A number of cylindrical wooden floats, 10.5 centimeters long and 8.5 centimeters in greatest diameter, are strung around the headrope about 40 centimeters apart and sufficient beadlike lead weights are also strung around the bottom rope at regular intervals. The floats and weights are held in place by seizings. The end of the wing is fastened to a wooden brail to which is attached a long heavy abacá rope for use in laying out the net and hauling the end of each wing up to the dugout.

Method of use.—Two large bancas, each manned by thirteen men, are employed in manipulating this round-haul seine. The net is carefully prepared in one banca, which is usually slightly larger than the other. One of the fishermen stands on the prow of each boat for the purpose of locating the school of mackerel; the watchers, therefore, direct the route of the outfit in the fishing grounds in water which is fairly deep and free from obstacles, such as a thick growth of marine plants or coral heads. As soon as the school of fish is located the boats are directed to head it off, and when a vantage point is gained the net is laid out as quickly as possible, in circular fashion, by the two bancas, so as to entrap the entire school. In other words, the smaller banca takes the pull rope of one wing of the net and

tows it around as the rest of the gear is paid out from the larger banca, which likewise maneuvers in the same manner. When the two boats meet the net lies like a huge circular curtain in the water. Hauling is now started and when the wings converge the fishermen beat the water inside the circle and make all sorts of noise to frighten and force the fish to spread and run into the meshes. The net is hauled on board the larger banca and placed on bamboo "holders" to facilitate the removal of the catch. Fishing with the kubkub is done only during dark nights when the movements of mackerel schools can be more readily detected.

KUBKUB SIMBADA

Localities.—Cadiz, Occidental Negros; Bantayan, Cebu.

Fishes caught.—Primarily chub mackerel (bulao, guma-a), and other commercial species that run in schools.

Description.—The *kubkub simbada* is a round-haul cotton net similar in material and style to the kubkub patiyoy. It is slightly smaller, being about 150 meters in length and from 20 to 25 meters in depth. The net has a stretched mesh of about 6 centimeters at the wings and about 5 centimeters at the bunt, or central portion. The upper line is well buoyed with wooden floats and the lower line is heavily weighted with lead sinkers strung about 30 centimeters apart. The floats and weights are held in place by seizings. The lead line is very much shorter than the headrope.

Method of operation.—A banca large enough to accommodate a crew of from sixteen to twenty men, together with the gear and other necessary equipment, is used to operate this kubkub in selected drifts or stretches of water that are fairly deep and free from snags. A watchman stands on the prow to scan the surrounding water for schools of mackerel; he thus directs the route of the boat. When laying out the net the end of one wing is first lowered; there is attached to this end a short rope carrying a buoy (*moron*) on which a lamp or torch is placed to indicate the position of the wing. The rest of the net is laid out in the usual way until the lighted buoy is reached. The net now lies like a circular curtain in the water. The pull ropes are hauled in rapidly, and as soon as the wing ends meet the plungers (tumbuk) are applied to drive the fish against the webbing. The net is sufficiently deep to preclude the escape of fish by diving or sounding as they are wont to do, especially when frightened and

cornered. The ends of the wings are taken to the banca and the two lengths of the lead line are crossed before hauling them rapidly aboard. By crossing the two sections of the bottom rope the apparatus is transformed into a sort of bag or large dip net. The fish that are not gilled are impounded in the bunt. These are collected with long-handled dip nets. Fishing with the kubkub simbada is done only during the dark of the moon.

LOOB

Locality.—Bantayan, Cebu.

Fishes caught.—Primarily mullet (gusao, *balanak*), siganids (*dangit, samaral*), whiting (aso-os), and prawns (*pasayan, locon*).

Description.—The *loob* is an interesting method in which are employed a rectangular set net, 5 meters long and 3 meters deep, without floats or weights, and such accessories as three or more dugouts, pieces of bamboo matting (*banata*), and bamboo or wooden stakes. The net is made of a coarsely woven abacá cloth (*salap*) or of No. 20 cotton twine hand knit with a mesh of about 3 centimeters, stretched. The abacá netting is hemmed and strengthened by a stout abacá twine; the four edges are attached to a strong abacá cord, which is extended about a meter from each corner of the net. The cotton netting is hung on all sides from four marginal cotton cords, which are laced through the marginal meshes of the net; the marginal meshes run freely upon the cords that are extended from each corner for tying.

Method of use.—The loob is operated in the shallow water along the shore. The net is set between two bamboo or wooden stakes driven into the ground obliquely shoreward. On the seaward side of the net bundles of sticks or switches are dropped to the bottom, and along the other side is placed an outrigger dugout upon which are spread two or four sections of bamboo matting (banata) in the form of a flattened V-like structure with the apex in the dugout. When the contraption is all set, two or three small boats go out to drive the fish towards the barricade. The fishermen beat the water, shout, and make all sorts of noise to frighten the fish, which upon being forced against the barrier, jump over it and land in the structure on the other side. This method of fishing is active during low tide at night and in the daytime. When a number of loob are set either in series or in one long continuous line in one locality, the entire outfit is called *patakiob*.

PAILIG

Locality.—Danao, Occidental Negros.

Fishes caught.—Mullet (gusao, balanak), halfbeak (bigiw), and other species entering streams during high tide.

Description.—The *pailig* is a set gill net made up of a number of pieces, each usually 5 meters long and 5 meters deep, hung perpendicularly from a number of bamboo or wooden stakes. The webbing is of No. 20 or No. 40 cotton thread, with a mesh of about 4 centimeters, when stretched. There are neither floats nor weights attached to the net. The marginal meshes run freely upon the marginal cords.

Method of operation.—A number of bamboo or mangrove stakes are driven into the bottom across a stream or river, about 5.5 meters apart, usually just a short time before the tide reaches its highest level. At the slack of the tide the pieces of net are fastened to the supports. Two or three fishermen in the water are required to accomplish this work. The net is left there until the water in the river gets low. The fish returning to sea with the ebb are intercepted and gilled. To hasten the movement of the fish towards the net the fishermen in small dugouts generally beat the water at the upper course of the river.

SAGAP

Locality.—San Jose de Buenavista, Antique.

Fish caught.—Bañgos fry (*awa-awa*).

Description.—The *sagap* (Plate 6, fig. 1) known also as *sayod*, is a small hand net about 5 meters long and 1.5 meters wide. The net is made in sections or pieces (*tinapac*) of finely woven abacá cloth or salap sewn together, hemmed, and strengthened along the four borders with a 2-ply abacá twine. The upper and lower margins are each attached to a stout abacá cord for holding. There are neither weights nor floats, so that either cord may serve as the bottom line.

Method of use.—The sagap is operated in very shallow water along sandy shores by two persons holding the marginal cords at the corners and dragging the net to catch the awa-awa, which are clearly seen moving rather slowly in groups. In scooping the fish, the bottom line is raised to the level of the upper border, which is always slightly above the surface of the water when in operation, and then the sides are gathered in so that the fish are bagged in the bunt or middle of the net, from which the catch is dipped out by means of a basin. The small creatures are carefully poured into earthen jars (*colon*).

LINES AND MISCELLANEOUS GEARS

LABAY

Localities.—Throughout the western Visayan region.

Fishes caught.—Red snapper (*maya-maya*), grouper (*inid*), grunt or croaker (abo), siganids (dangit, samaral), Spanish mackerel (*tañgigi*), tuna (tuliñgan), pampano (lison, badlun, mamsâ), and other important species.

Description.—The *labay* is a trawl or trot line, consisting of a stout twine varying in length from 50 to 200 meters, on which are attached, at certain intervals, a number of short lines or snoods with hooks. The snoods are shorter than the intervals in order to avoid the fouling or crossing of two adjacent short lines.

Method of use.—The line is usually coiled in a shallow basket, and the hooks are stuck in an orderly manner to the rim of the container. A narrow strip of wood or bamboo slit lengthwise to hold the hooks is also used for the same purpose; in fact, this is handier than the basket, although the latter is the more popular. When the hooks are baited, the main strand or twine may be anchored at both ends, to which are attached floats to indicate their positions. The line may be set at any desired level in the water across the general drift of the current. The "interceptor," as the vernacular name, *labay*, means, is left for a few hours and then raised and examined. If it is intended to fish in the same place, the hooks are rebaited immediately after the catch is removed; the weights for anchorage are lowered and the floats placed in position. For bait, tough meat and fresh or stale squid are used. Generally, two fishermen operate this line from a dugout canoe or *baroto* of the outrigger type. It appears that this sort of fishing is of recent introduction.

SIBIDSIBID

Localities.—Throughout the western Visayan islands and elsewhere.

Fishes caught.—Barracuda (*rompe candado, torsillo, bansa, asogon*), tuna, (tuliñgan), Spanish mackerel (tañgigi), pampano (lison, badlun, mañgudlong, mamsâ), leather jacket (*lapis*), sergeant fish (*pandawan*), and other swift-moving predatory species of commercial importance.

Description.—The *sibidsibid* is also called *pagoyud*, meaning troll or troll line. It consists of a stout twine or rope, 20 to

50 meters long, carrying a good-sized baited hook. The hook is generally fashioned out of an iron or copper rod. Unlike the modern troll line, the sibidsibid, as used by native fishermen, is not provided with a spoon; but instead, with a sort of jig consisting of a ring with white chicken feathers or pieces of white cloth; usually, however, there is no ring, and the feathers or pieces of cloth are simply fastened to the hook in the manner of a fly or lure. At Estancia the hooks are baited with live sardines to catch tañgigi.

Method of use.—A specially built outrigger dugout, locally called *pinanyo* (from the handkerchieflike sail with which it is equipped) or *sibidsibiran*, is employed to tow this line. The boat, which is generally a one-man dugout canoe of the outrigger type, is fairly seaworthy and its large sail enables it to run at good speed with the wind, drawing the baited hook through the water just below the surface. Fresh sardines, herrings, or fresh squids are the commonest natural baits; white chicken feathers and pieces of white rags, as already stated, constitute the "artificial baits" or lures. As the fish strikes, the boat is immediately hove to and the line is hauled in. A fight between the captor and captive generally ensues, especially if the hooked animal is of a stubborn kind, like the barracuda. After the fish is landed in the boat, the hook is rebaited, cast into the water, and trolling is resumed until a strike is made.

LOCON-LOCON

Localities.—Cadiz, Escalante, Occidental Negros; Bantayan, Cebu, and elsewhere in the western Visayas.

Fishes caught.—Squids (*locus*).

Description.—The *locon-locon* (fig. 6) is a wooden imitation of a prawn, known locally as *locon*, hence the term "locon-locon," which literally means "prawnlike." It is usually about 15 centimeters in length over all, provided on top of the tail end with two series of forward-pointing recurved hooks. The artificial eyes are made of four glistening yellow beads strung on a thread that is passed through a hole on top of the head; the swimmerets are represented by a number of tufts of abacá fiber or gray-and-white chicken feathers arranged in two parallel rows on the lower part of the abdomen. The lure is generally painted black, except of course the swimmerets and eyes. A towline is fastened at the snout.

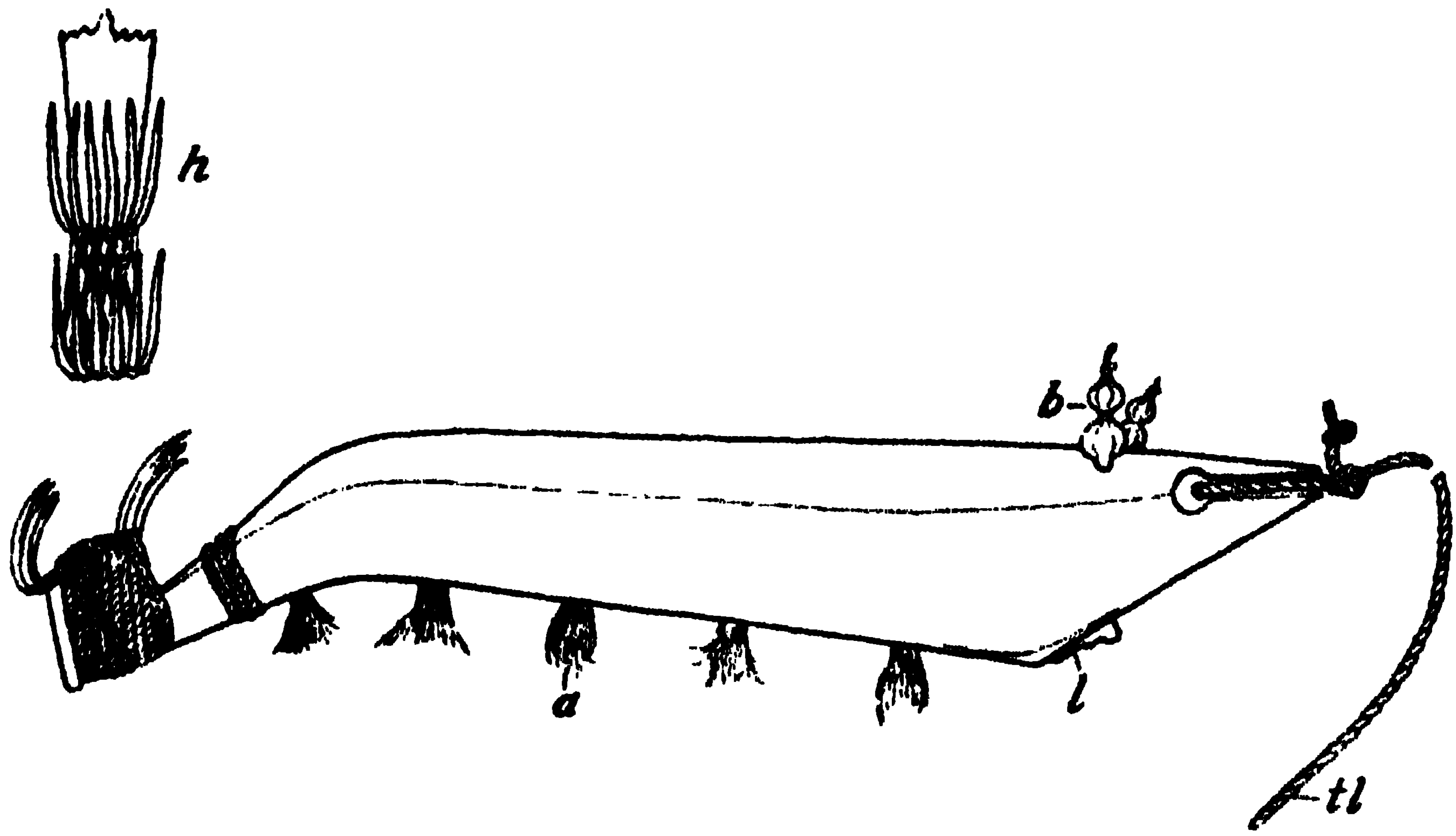

FIG. 6. Diagrammatic sketch of locon-locon; *a*, abacá fiber; *b*, yellow beads; *h*, hooks, top view; *l*, lead weight; *tl*, towline.

Method of use.—The locon-locon is drawn through the water near the surface from behind a dugout, and in order to hook the squid that has been attracted, the line is jerked occasionally. The fisherman can immediately feel when a "strike" is made; he then hauls in the line rapidly, removes the catch, and casts the lure back into the water. This method of fishing is used only during dark nights.

BINTOL

Localities.—Throughout the western Visayas.

Fishes caught.—Crabs (*alimañgo, kasag, dawat*).

Description.—The *bintol* is a familiar scaff net or dip net, usually 30 to 35 centimeters square. The webbing, always knit by hand, is of cotton or abacá twine, with the meshes varying from 3 to 5 centimeters square. The net is suspended horizontally by the corners from two bamboo crosspieces or bows of equal length. These pieces are appreciably longer than the diagonals of the net, so that they hold the sides of the net taut. Stone or lead weights are usually attached to the extremities of the crosspieces to accelerate the sinking of the apparatus and to insure the right position as well as the anchorage on the bottom. At the intersection of the crosspieces the pull line carrying a float is attached; at this point also the bait is suspended.

Method of operation.—The baited trap may be set on the bottom of creeks, rivers, seashores, and estuaries where it is left for a certain length of time. The fisherman, when hauling it,

uses a sort of grapnel or simply picks up the float with his hand. As soon as the net is raised above the water, the crab detaches itself from the bait only to fall into and become entangled in the meshes of the net. For bait, tough pieces of meat, fish, or crab are used.

TIKPAO

Localities.—Throughout Panay, Negros, and Cebu.

Fishes caught.—Primarily mullet (gusao, balanak) and crabs (kasag).

Description.—The *tikpao* (Plate 1, fig. 1) is a familiar bag-like dip net used extensively in the Visayan region. The webbing, always knit by hand, is of cotton twine, rigged around an oval frame of bamboo slats lashed at an angle to a long bamboo handle. The bag, held more or less rigid by a splint bent from the oval frame to the handle, is about 24 centimeters in depth and its mouth is usually 36 centimeters and 18 centimeters in diameter. The netting has a mesh of 15 millimeters square.

Method of operation.—The tikpao is used in connection with torchlight fishing in rivers, lakes, and in the sea along the coast during fair weather and dark nights, and requires a banca and two men for its operation. One man stands in the prow of a dugout and holds the dip net in one hand and the torch in the other; the other man at the stern steers the boat with a paddle according to the directions of his partner. Upon seeing a fish or crab, the fisherman brings down the dip net in a sudden sweep to capture the animal, and with a turn of the wrist lifts the scoop with the mouth right side up and empties the catch into the boat. The entire manipulation takes but a minute to perform. Skill is required to wield the tikpao properly.

SUNGYA

Localities.—Throughout the Visayan region.

Fishes caught.—All kinds of small fishes as well as shrimps, prawns, and crabs.

Description.—The *sungya* (Plate 1, fig. 2) is a primitive one-man apparatus, which is a combination of a dredge and a dip basket. It is triangular in general form, about 70 centimeters wide at the mouth, and 80 centimeters long, and has a handle and a bag with a basket. The main body of the implement is made up of finely woven bamboo matting. At the middle of a crosspiece bent across the mouth is attached a bamboo handle, the far end of which is fastened at the narrow funnel-shaped

extremity. It may be accompanied by a "driver" consisting of a handful of switches or of a small bamboo pole split at one end and spread by a crosspiece as long as the width of the mouth of the sungya proper. Shells are impaled on the crosspiece of the driver.

Method of use.—The sungya is dragged from the front, side, or back, and the "driver" is worked in such a way as to drive the fish into the scoop. If no driver is used the foot of the fisherman is employed for the purpose, although this is not usually practiced as there is always danger from the sting of the poisonous spines of fishes that generally live in surroundings where the sungya is operated.

TACLUB

Localities.—Throughout the western Visayan provinces.

Fishes caught.—All kinds of fishes and crustaceans.

Description.—The *taclub* (Plate 2, fig. 1) is a portable cone-shaped bamboo trap varying greatly in size and mesh. For sides it has bamboo slats fastened with rattan to a number of hoops of different diameters. The uppermost hoop is the smallest, but it is always large enough for a man's hand and arm to pass through easily. The rim of this opening is generally reënforced with rattan lacings of a more or less artistic arrangement to provide a good grasping surface. The lowest hoop is usually the largest and is only a few centimeters above the sharpened free ends of the slats.

Method of use.—This is one of the handiest implements for catching fish, shrimps, and crabs in fishponds, creeks, and in the shallow water of tidelands and tidepools. The apparatus is simply placed suddenly over the victim which is then drawn out by hand through the upper opening. It is used in the daytime and at night.

BUBU, OR BOBO

In the Philippines there is probably no type of fishing implement that presents more varied shapes and peculiarities than the so-called *bubu*, or *bobo;* and a collection of bubu from the various regions of the Archipelago would perhaps be the most heterogeneous assemblage of related fishing apparatus that could be brought together. The differences in form are due to variations in the shape of the individual parts and in the arrangement of the parts with reference to each other. The ingenuity of the individual makers is, of course, reflected in the divergent styles thus produced.

Bubu, or bobo, is a general term given to portable traps of bamboo, rattan, or wood, varying in size and shape, with one or more entrances. They are widely used in the rivers, lakes, and fishponds, as well as in the open sea. A number of variations exist in different localities, but every one of these devices works on the principle of a rat trap.

BUBU KINABAN

Localities.—Cadiz, Escalante, Occidental Negros, and elsewhere.

Fishes caught.—All kinds of bottom fishes, lobsters, and crabs.

Description.—The *bubu kinaban* (Plate 3, fig. 1) is a rectangular bamboo fish trap varying in size and having one or two openings or fykes formed of pliant and sharpened bamboo slats converging at a point inward. In small traps no weights are used, but in the large ones stone weights are fastened to the bottom. A strong rope or rattan is tied to the apparatus for the purpose of lowering and hauling. Attached to the upper extremity of this rope is a float to indicate the position of the trap. The bubu has a trap door temporarily tied with rattan, and through this opening the catch is removed.

Method of use.—The trap is taken out in a banca and lowered at a favorable locality and left there for a certain length of time, after which it is raised. Bubus that are set in deeper water have their floats usually submerged about a meter from the surface during the lowest ebb to minimize detection and abuse by poachers. Deep-sea bubus are set at the intersection of two straight lines formed by four fixed points on land. Conspicuous land marks, such as, mountain peaks, tall trees, and church towers, are usually selected for this purpose. A bamboo pole with a hook or a stout rope with a hook or anchor is used for grappling the haul lines of the traps. The bubus are baited with beef, dead fish, squid, or roasted copra. A piece of white rag, tin, or plate is also used with good results. The deep-sea traps are hauled up generally once or twice in twenty-four hours; the smaller bubus more frequently. The catch is removed through the trap door.

DAPLAK

Locality.—Escalante, Occidental Negros.

Fishes caught.—Bottom fishes, large prawns, lobsters, and crabs.

Description.—The *daplak* (Plate 3, fig. 2) is a bubu of bamboo, more or less shoelike in form, with a single entrance at the large end provided with the usual funnel of converging sharpened slats. It varies greatly in size. The trap rests on its "sole," or flat bottom, which is a separate piece attached to the sides by means of a rattan lacing.

Method of use.—It is set practically in the same manner as the preceding. The smaller size, usually set near the shore, is hauled up quite often.

TAUN

Taun is a generic name given to conical bamboo traps with an opening at the large end. The mouth may be circular, rectangular, or hexagonal, and the entrance is a funnel formed by slats that project and converge inwardly. The taun varies a great deal in size. Two variations are here described.

TAUN LIGID

Localities.—Sicaba, Cadiz, Occidental Negros, and elsewhere in the Visayan region.

Fishes caught.—Small fishes, shrimps, prawns, and crabs.

Description.—The *taun ligid* (Plate 2, fig. 2, *a*) is a cylindrical bamboo trap with a tapering end. It is made out of a bamboo pole split into slats, which are fastened with rattan to a number of bamboo or wooden hoops. The entrance is in the form of a funnel constructed with sharpened splints pointing and converging inward. A sort of trap door is located at a point near the greatest circumference. The apparatus carries a pull rope with a float tied to its free end.

Method of use.—Used in creeks, rivers, and fishponds, and in the sea. The smaller taun is simply placed on the bottom without any weight and left there for a certain length of time, after which it is raised. The catch is removed through the trap door. This apparatus may or may not be baited. When used in small creeks with fast-running water it is set unbaited with the mouth against the flow of the current. Usually it is placed at the apex of two fences of bamboo slats which are set in a V-form, so that it serves as a pocket or pound. The larger traps are baited with stale meat or fish wrapped in salap or other cloth and set in the deep water off shore, preferably near coral reefs.

TAUN KINABAN

Localities.—Cadiz, Escalante, Occidental Negros; Bantayan, Cebu.

Fishes caught.—Bottom fishes, prawns, lobsters, and crabs.

Description.—The *taun kinaban* (Plate 2, fig. 2, *b*) closely resembles the taun ligid except in the shape of the mouth, which is rectangular. The four-sidedness is carried to almost three-fourths the length of the apparatus; the last fourth is rounded and tapers to a closed end.

Method of operation.—This trap is used in the same manner as the last type described.

PANGGAL

Localities.—Sicaba, Cadiz, Escalante, Danao, San Carlos, Occidental Negros; Bantayan, Cebu.

Fishes caught.—All kinds of bottom fishes, as well as crabs, large prawns, and lobsters.

Description.—The *panggal* (Plate 4, figs. 1 and 2) is a globular bamboo or rattan trap with the opening at the top. The circular entrance is not guarded by slats, but there is a short collarlike piece projecting inward. The flat circular bottom upon which the trap rests is detachable and is held in place by a weaving of rattan.

Method of use.—Used in rivers, lakes, and the sea. It is baited with stale meat or fish or with moss strung on a twine across the diameter of the trap. Stone weights are fastened to the bottom on the inside to insure an upright position when the trap is resting on the ground. Attached to the apparatus is a pull rope of strong twine or rattan with a bamboo float at its free end. The basket is taken out in a banca and dropped in some favorable locality, left there for a period of several hours, and then examined. The catch is removed by loosening the rattan lacing holding the bottom piece. Oftentimes this basket is used by fishermen engaged in handline fishing as a live box for living bait. When used for this purpose, it is called *palan-an*, meaning "a receptacle for bait."

TIMING

Localities.—Escalante, Occidental Negros; Bantayan, Cebu.

Fishes caught.—Primarily shrimps, prawns, and crabs, as well as small fishes.

Description.—The *timing* (Plate 5, fig. 1) is a fish basket made of rattan or bamboo. It is characteristically a four-cornered globular apparatus with a circular opening constructed in the same manner as the mouth of the panggal. It is provided with a haul line that carries a float at the free end.

Method of use.—Used in rivers, swamps, fishponds, lakes, and in the shallow water of muddy shores. It is baited with algæ, which are fastened inside at the center of the bottom. The trap is taken out in a banca and lowered at a favorable locality where shrimps and crabs are known to be abundant. The catch is removed through the mouth.

BANTAK

Localities.—Escalante, Occidental Negros; Bantayan and Mactan, Cebu.

Fishes caught.—Small bottom fishes; such as, gobies (*gamia*) and shrimps or prawns (pasayan, *balaskugay*).

Description.—The *bantak* (Plate 5, fig. 2) is a small portable more or less conelike trap, 18 to 40 centimeters in length, and 7 to 14 centimeters in greatest diameter. It is constructed of finely smoothed bamboo splints, rattan, and other vines. In form it represents all the possible variations of a cone; usually it is similar to a long- or short-necked bottle with an opening at each end; the entrance at the larger end is always funnel-like with a number of terminal splints that are free, pliable, and converge inwardly to a point; the opening at the tapering end is kept closed with a wooden plug. The trap is provided with one or more ringlike attachments to which the pull line, a rope or rattan, is fastened.

Method of operation.—The bantak, after being baited with algæ (lumut), is set on the bottom of creeks, rivers, fishponds, and tidal flats, and its position is indicated by a float at the free end of the pull line or by a stake to which the pull line is tied. The apparatus is left for a certain period and then hauled up. The plug is removed and the contents are shaken into a collecting receptacle, usually a small hand basket or bag of salap (abacá cloth).

FISH CORRALS (PUNUT OR BUNGSOD)

Localities.—Around the coasts of the Visayan islands.

Fishes caught.—All kinds of fishes and crustaceans.

General description.—The *punut*, or *bungsod*, is commercially the most important fishing apparatus in the Visayan region. The typical punut is a large stationary fish corral made of rows of stakes with bamboo fences and consists of a more or less intricate system of inclosures with the usual arrangement of an easy entrance but difficult exit. The fences are composed of a number of separate sections or units called *banata*, each of which is made of a definite number of splints (*lag-i*) the size of a pencil or a man's thumb, woven side by side at certain regular intervals or spaces (*salad*) with a number of lacings (*tagik*) of rattan (*Calamus* sp.), *hagnaya* (*Polygala venenosa* Juss.), or *sig-id* [*Malaisia scandens* (Lour.) Planch.]. A finished section resembles a large porch screen and can be rolled up for handling; it varies from 1 to 10 centimeters in mesh, 5 to 20 meters in length, and 5 to 25 meters in width or depth. The sections with smaller meshes are used around the collecting chamber and the next one or two compartments immediately preceding it; and those with larger spaces are placed around the forechamber, wings, and leader. They are fastened to the uprights and braces with rattan; their lower edges touch the ground and their upper extremities project about a meter above the level of high tide. The stakes, which are set from 1 to 2 meters apart, rise about 3 meters above the maximum tide mark. The collecting chamber is built in the deeper water and the leader from the deeper to the shallower water. The leader, the length of which varies with circumstances, usually extends in a straight line from a point on or close to the shore at right angles to the supposed direction taken by the fish as they drift with the current. The wings, which are similar to the leader in construction and supplemental to it in purpose, are extensions arising from a common center with the leader but diverging towards the shallower water. Like the leader they are also set at an angle with the current to intercept the passage of fish and to direct them into the corral.

The principle upon which the punut functions is always the same in all styles; that is, to lead the fish into inclosures or traps by means of runners; but the actual setting and arrangement of parts vary in different localities, thus giving rise to a number of ingenious types. Along the coasts of Iloilo, Negros, and Cebu there are no less than ten different styles in use, but six of these are considered the most important commercially and are always

the dominant types to be found lining the sheltered bays and coastal waters in the Visayas during the northeast and southwest monsoons. These effective variations are known locally as *tulis, linatî, inangcla, hasang simple, hasang antiguo,* and *hasang moderno.* Another type of fish corral, which is just as important commercially, is the *pahubas.* This is set on the tidal flats. Besides these, there are still other less-pretentious structures; such as, the *tangcup, saplad,* and *sira,* or *lapac* which are usually set in shallow water.

TULIS

Description.—A typical *tulis* (fig. 7) consists of a heart-shaped terminal chamber (*bonu-an*), *tp*, followed by a triple pyramid-in-pyramid arrangement of successive compartments, a linear fence or leader (*táktakon*), *l*, and two wings (*pamakô*), *w*. The leader arises from the middle of the central gate (*pamuerta*), *m*, of the first or largest triangular inclosure (*ligao*

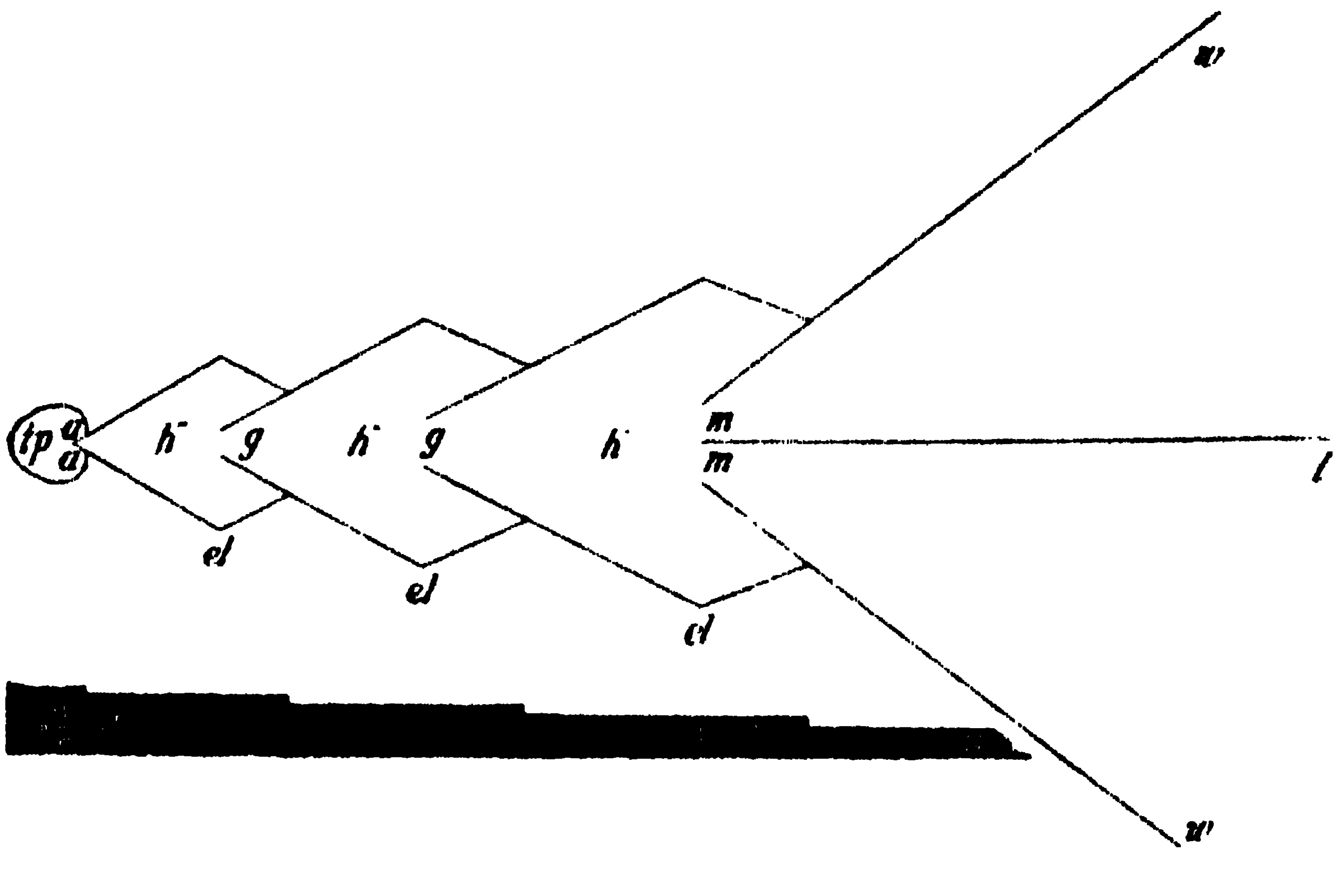

FIG. 7. Diagram of tulis: *a*, apron (domilâ); *el*, elbow (pagsiko); *g*, gate (pamuerta); *h'*, first heart (ligao dakû); *h''*, second heart (ligao diutay); *h'''*, third heart (sagaran); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *tp*, terminal pound (bonu-an).

daku), *h'*, the direction of the front walls of which determines the position of the wings. Superimposed upon the first compartment is the second slightly smaller triangular chamber (*ligao diutay*), *h''*, and between this and the terminal crib is the smallest triangular section (*sa-garan*), *h'''*, the apex of which.

provided with two flaps or aprons (*do-milâ*), *a*, enters the collecting pound. The plan of the apparatus resembles an arrowhead from which similarity it derives its vernacular name. It is said that the tulis is the oldest type of gear in the Visayas, if not in the Philippines. It is characterized by a geometrical symmetry that is better appreciated in a diagram than in a written description.

Method of operation.—The compartments are dragged or seined successively with a roll of bamboo screen called *sigin* or *gayad*. This consists of two or three separate sections joined together and is provided at each vertical border with a bamboo brail that is rotated to facilitate the rolling or unrolling of the screen. The seining is started from the first or forechamber, the outer heart, and ends in the circular pound. The sigin is first stretched across the main gate to preclude the escape of fish; it is then worked slowly towards the opposite or narrow end and the divers see to it that no fish break back by keeping the bottom of the sigin flush to the ground and the two sides close to the walls of the compartment. The fish are herded into the next chamber. The procedure is repeated in each succeeding section until the fish are finally impounded in a well about a meter in diameter in the crib, from which they are brailed out with dip baskets (*sihud*) into a large wooden box or into several large baskets (*batulan*) on the platform (*horma*) near the center pole (*palo*). The catch may be transferred directly to the waiting boats. Loading is facilitated by the use of a boom and block and tackle, which all serve the purpose of a simple derrick.

LINATI

Description.—The *linatî* (fig. 8) is one of the simplest types and apparently is the forerunner of the later and more-complicated fish corrals in the Philippines. Its vernacular name is derived from the crescent shape of its single large inclosure (*bulon*), *si*. The chamber has a wide central opening (*pamuerta*), *m*, from the middle of which extends a long linear fence or leader, *l*. The diverging front walls of the entrance are prolonged to form the wings (pamakô), which may be as long as the leader. The narrow extremities of the bulon are square-cut and each is provided with a bamboo platform (*salyadahan*), *lp*. All around the inclosure a scaffolding is built for the fisherman to work from.

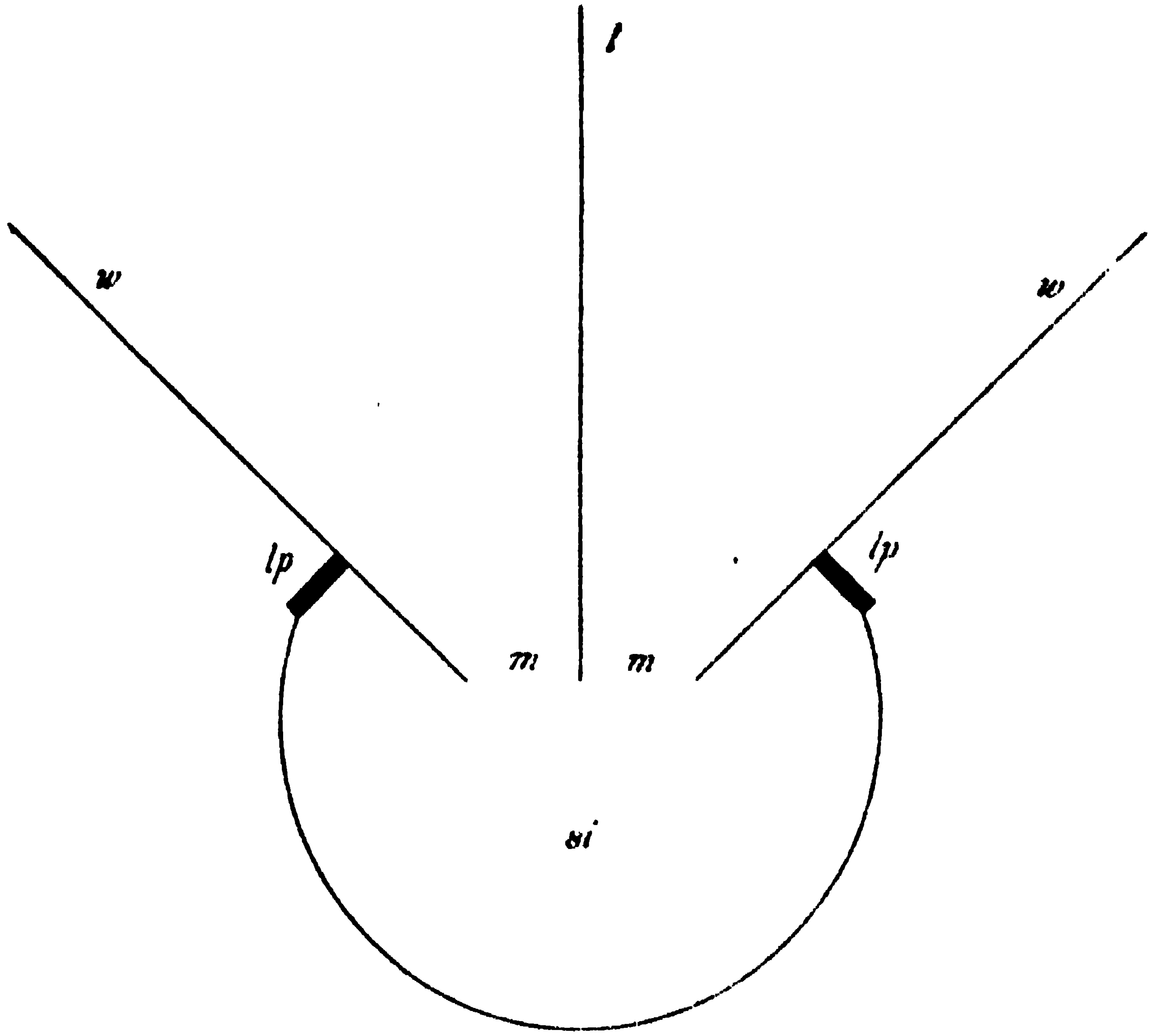

FIG. 8. Diagram of linati; *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *lp*, landing platform (salyadahan); *si*, semicircular inclosure, or main body (bulon).

Method of operation.—In the operation of this type it is necessary to have a watchman on the corral all the time to close the gate and to signal to his coworkers on the seashore whenever it is time to make a haul. Before his companions arrive he prepares the rectangular collecting net, or sigin. This seine is provided with lead sinkers along one edge and pull ropes on all sides. It is dropped from either platform, whence it is worked to the opposite end. The weighted side is hauled up so as to convert it into a large dip net. This particular method of collecting the catch is called in the vernacular *paduyan*, meaning "swinging in a hammock." The catch is transferred to the waiting boats outside below the platform.

INANGCLA

Description.—Obviously the *inangcla* (fig. 9) is an evolution of the linati. It is anchorlike in form, from which similarity it

gets its Visayan name. The leader corresponds to the shank and the semicircular inclosure (bulon), to the crown; each arm carries a triangular palm (sagaran), *tc*, and terminates in a heart-shaped bill or pee (bonu-an), *tp*, which is the collecting crib. The long linear fence, as usual, extends from the middle of the main entrance (pamuerta), *m*, towards the shallower

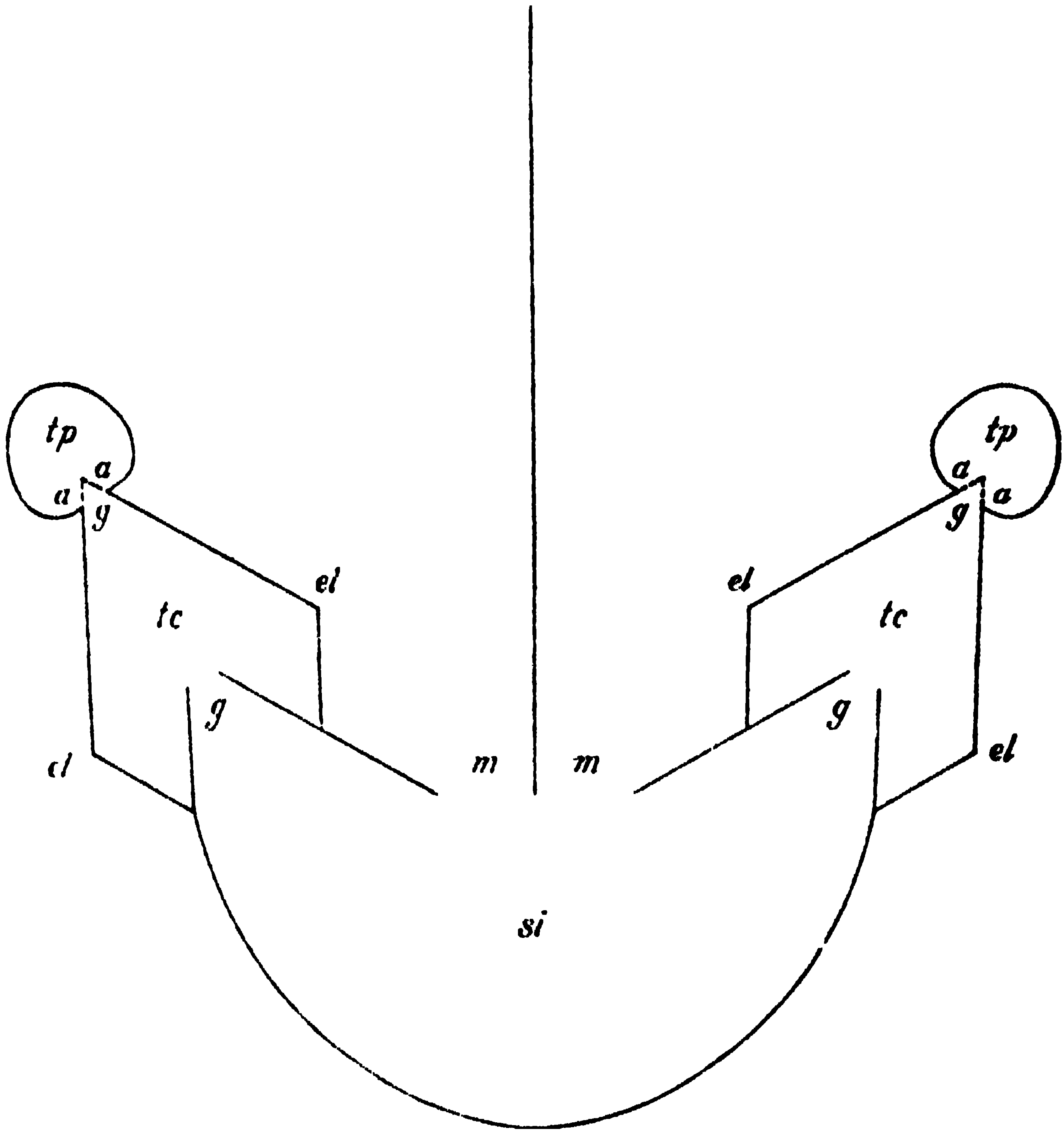

FIG. 9. Diagram of inangcla; *a*, apron (domilà); *el*, elbow (pagsiko); *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *si*, semicircular inclosure (bulon); *tc*, triangular compartment (sagaran); *tp*, terminal pound (bonu-an).

water. The two diverging extremities of the bulon with their superimposed identical inclosures flank the leader on each side, thus serving as runners or wings to intercept the passage of fish and lead them into the trap. The plan of the inangcla is based upon three straight lines radiating from a common center, the

middle one of which bisects the angle formed by the other two. The bisector coincides with the leader of the trap.

Method of operation.—The *banata sigin* is used and operated the same as described in connection with the tulis. The main entrance is first closed with banata; then the bulon is seined until the fish are deposited into the next triangular chamber (sagaran) where the work is resumed until the catch is impounded in the terminal pound, from which it is brailed out with dip baskets into receptacles on the platform or directly into the waiting boats.

HASANG SIMPLE

Description.—The *hasang simple* (fig. 10) is characterized by its simplicity of construction. It consists of several parts;

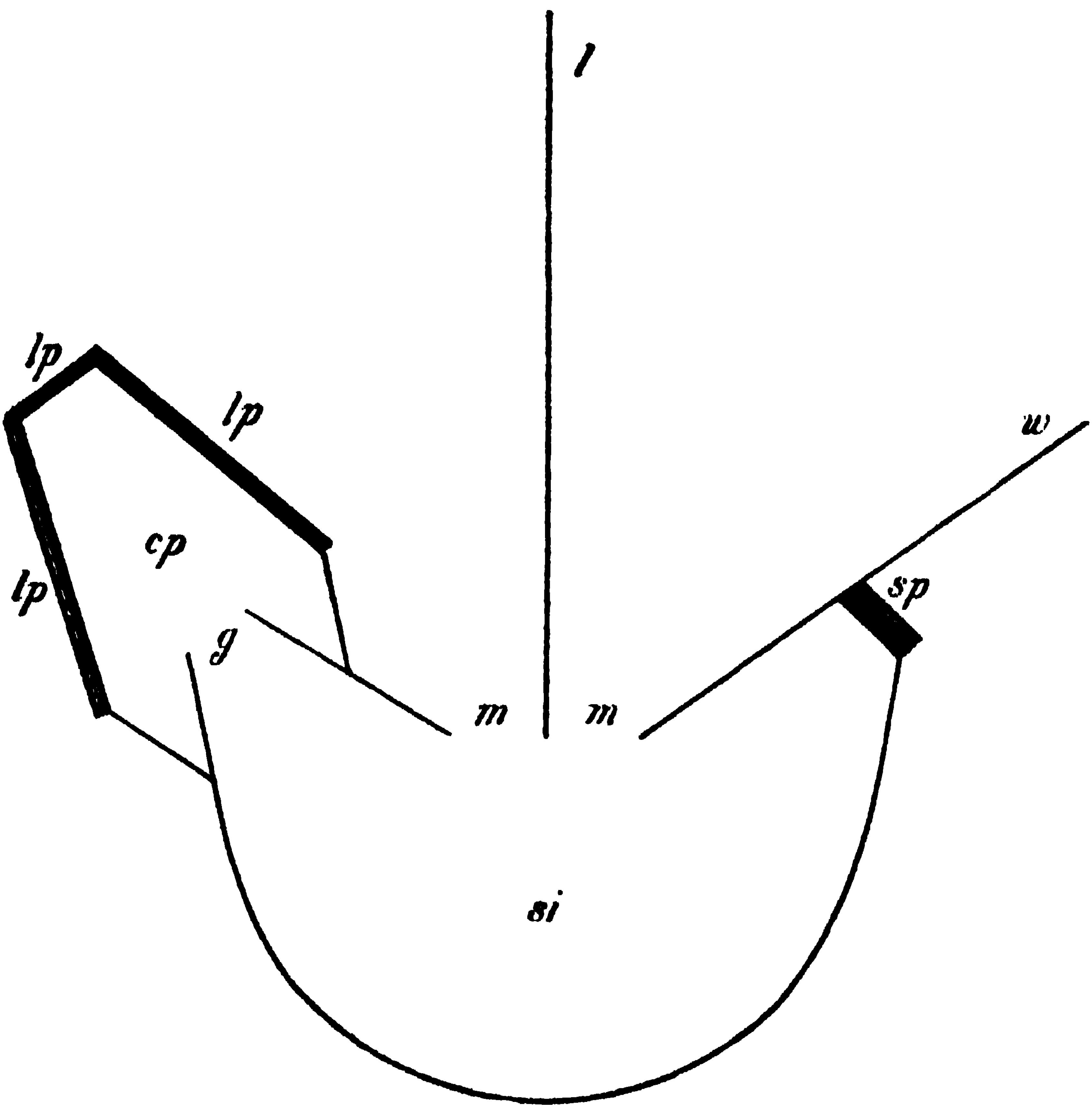

FIG. 10. Diagram of hasang simple; *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *cp*, collecting pound (sagaran); *lp*, landing platform (salyadahan); *si*, semicircular inclosure (bulon); *sp*, seine platform (kinaban).

namely, a collecting chamber (sagaran), *cp*, which resembles a plane-peaked pyramid; a large crescent-shaped inclosure (bulon), *si*; a wing (pamakô), *w*; and a long linear fence (táktakon), *l*, that extends from the middle of the main gate (pamuerta), *m*. The narrow end of the bulon is open and forms the entrance to the collecting pot; the other end is closed and square-cut and provided with a platform (kinaban), *sp*; the front wall of the closed end is extended to form the wing. There is a platform around the three sides of the sagaran and a scaffolding along the perimeter of the forechamber.

Method of operation.—As in the linatî, a watchman is also employed for the same purpose. After the main gate is closed with banata the compartments may be dragged with either a cotton seine or banata sigin. The cotton seine is dropped from the square-cut end (kinaban) and gradually worked into the sa-garan where the fish are bagged by lifting the weighted side so that the net is converted into a sort of hammock. When the banata sigin is used the procedure is exactly the same as previously described.

HASANG ANTIGUO

Description.—The *hasang antiguo* (fig. 11) represents a typical punut with a compartment called *hasang*, meaning "gill." The designation is probably based upon the position of the inclosure rather than upon its form, which varies from rectangular to triangular. The hasang antiguo consists of the following principal parts: The leader, *l*, the two wings, *w*, the forechamber (hasang), *fc*, the semicircular inclosure (bulon), the triangular section (sa-garan), and the heart-shaped terminal pound (bonu-an), *tp*. The structural details of all these are too complex to be followed in a written description and can be better appreciated in a diagram.

Method of operation.—As in all fish corrals with a more or less circular collecting chamber, the banata sigin is considered more handy to work with than the cotton net; however, the latter is often employed in seining the large compartments. In this type, both kinds of sigin are utilized to advantage. The manner of handling each has already been described in the preceding paragraphs.

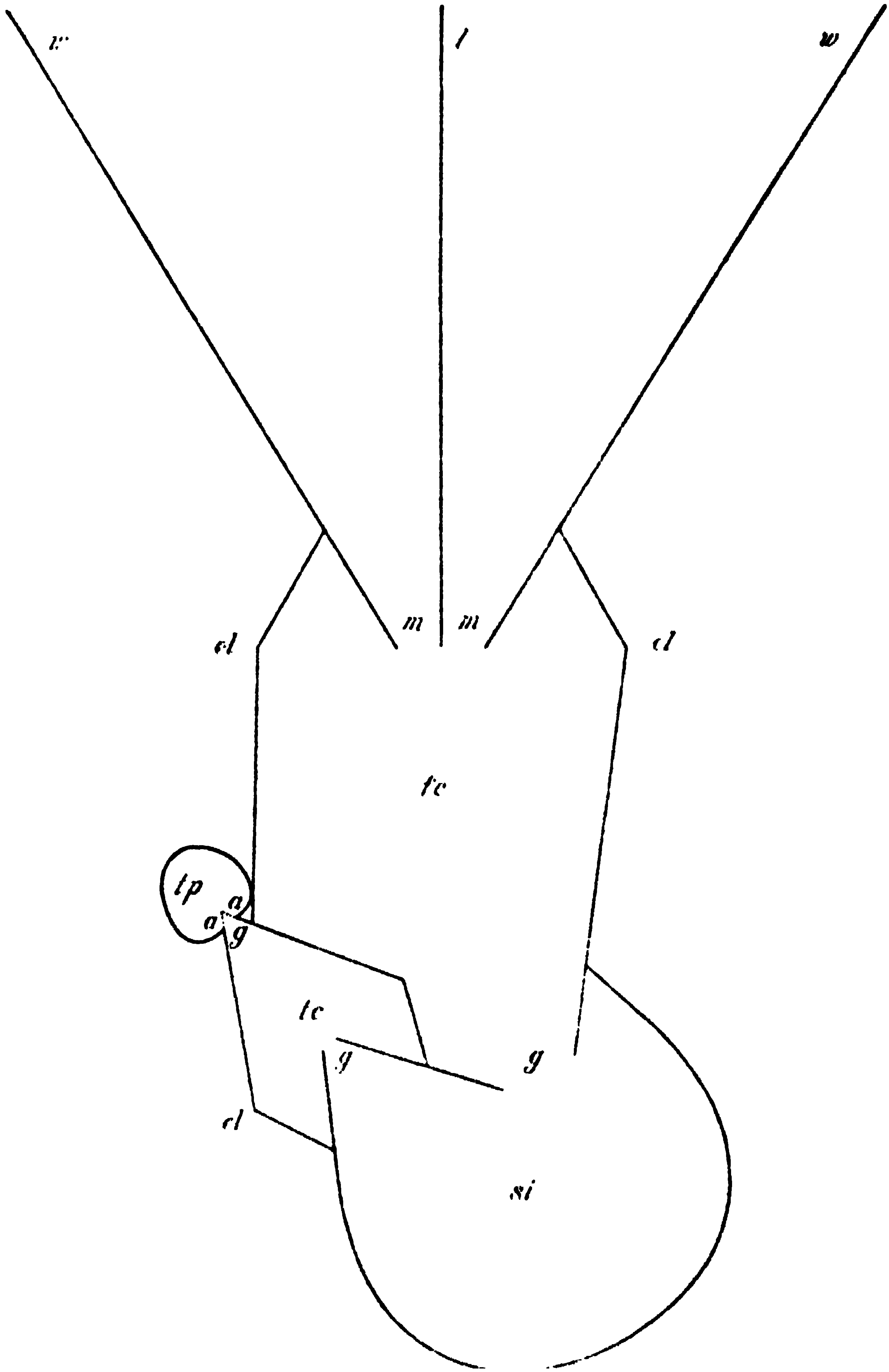

FIG. 11. Diagram of hasang antiguo; *a*, apron (domilá); *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *el*, elbow (pagsiko); *fc*, forechamber (hasang); *si*, semicircular inclosure (bulon); *tc*, triangular compartment (sagaran); *tp*, terminal pound (bonu-an).

HASANG MODERNO

Description.—The construction of this punut (fig. 12) is characterized by a combination of some of the best features of the other types. The *hasang moderno* is considered the most effective of all the fish corrals in use in the Visayan region.

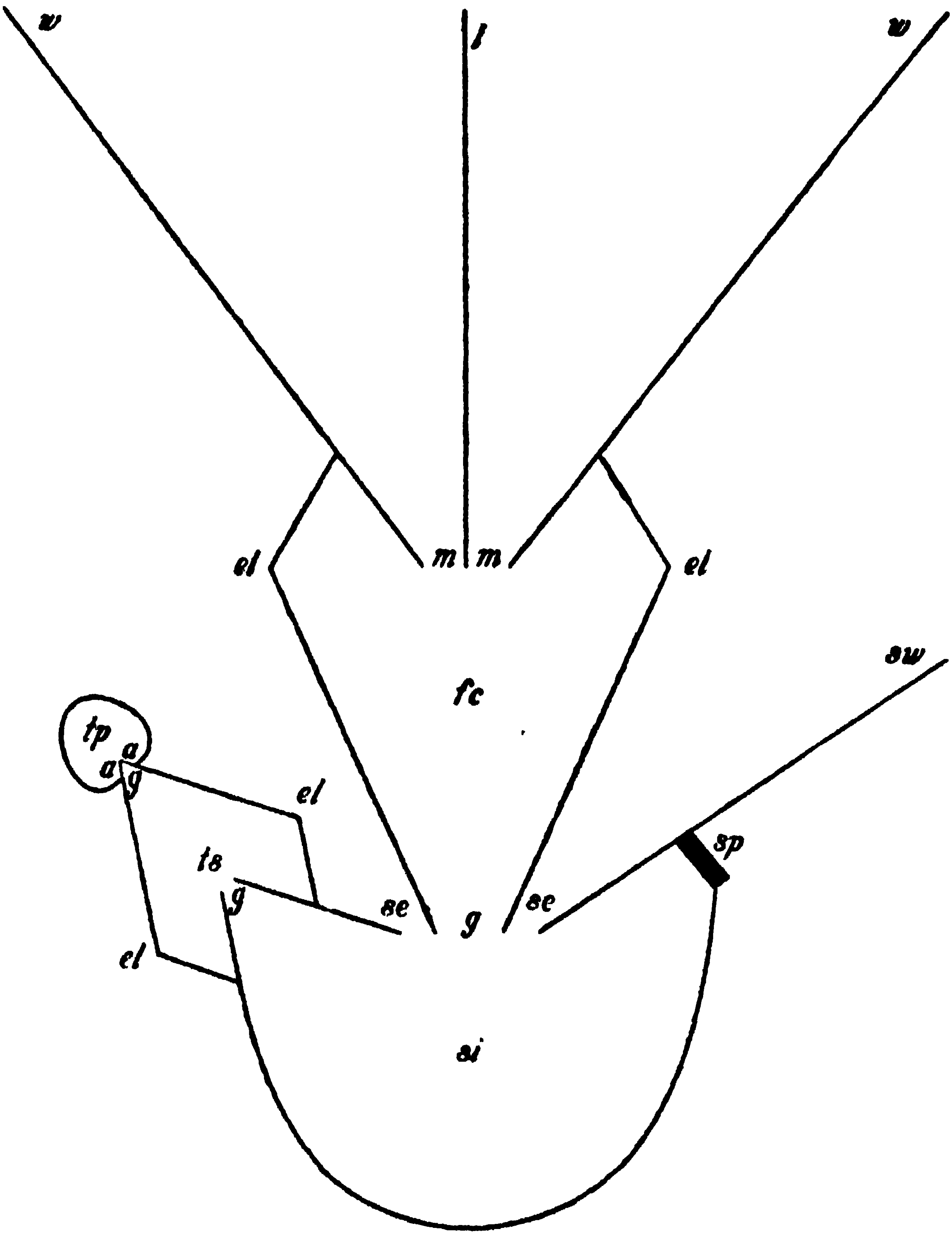

FIG. 12. Diagram of hasang moderno; *a*, apron (domilâ); *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *el*, elbow (pagsiko); *fc*, forechamber (hasang); *se*, side entrance (pamuerta); *si*, semicircular inclosure (bulon); *sp*, seine platform (kinaban); *sw*, secondary wing (pasalô); *tc*, triangular compartment (sagaran); *tp*, terminal pound (bonu-an).

Like the hasang antiguo, it has a heart-shaped terminal pound (bonu-an), *tp*, superimposed upon the small triangular compartment (sagaran), *ts*, and the large semicircular pasture (bulon); but unlike its prototype, it has, instead of a large rectangular inclosure a spacious triangular forechamber, *fc*. Both compartments, however, are designated by the same vernacular name, hasang, in spite of their difference in form. In the hasang antiguo, there is only one gate into the half-moon inclosure, whereas in the type under consideration there are three gates, the middle one being formed by the open narrow end of the V-shaped antechamber and the other two by the diverging front walls of the adjacent inclosure. The leader and wings are similar to the preceding type. The other details are better followed in a diagram than in a verbal description.

Method of operation.—Wherever possible cotton net and banata sigin are used in gathering the catch. The procedure in operating these "seines" is as has already been described. In the collecting pound there is the usual improvised derrick to hoist and lower the fish baskets.

PAHUBAS

Description.—The *pahubas* (fig. 13) is a temporary bamboo corral set on flats or gradually sloping shores to catch fish frequenting the intertidal zones. It varies a great deal in size from a small weir of about 100 meters in extent to a pretentious inclosure covering a few hundred square meters in area. When set, it consists of two V-shaped wings (pamakô); two triangular compartments (ligao and sagaran) in a pyramid-in-pyramid arrangement, the ligao being constructed at the converging point of the lateral fences; and the terminal heart-shaped pound (bonu-an). Each wing is composed of a number of units of bamboo screens (banata). These screens are each 5 meters long and vary from 1 to 5 meters in depth or width. Like the wings, all the other parts have a definite number of banata for walls. The ligao has 12-piece units, the sagàran 6, and the pound 4; each of these units is 5 meters long and 5 meters wide. The stakes supporting the walls are of mangrove and the braces of bamboo.

Method of operation.—The stakes are set during the lowest tide in order to facilitate the work and to locate easily the proper positions of the various parts. The three compartments all complete are built where the water is from 2 to 3 meters deep

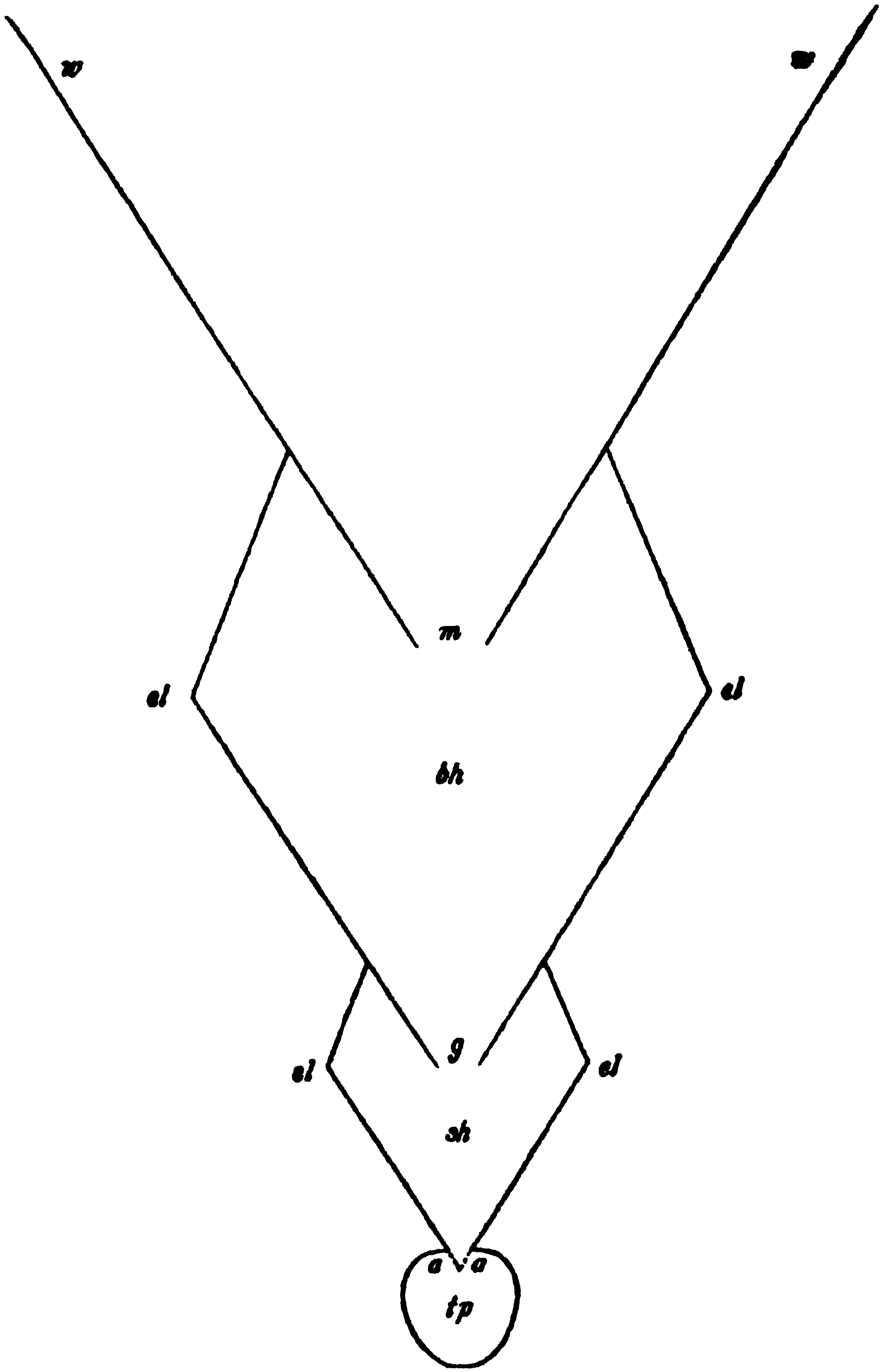

FIG. 13. Diagram of pahubas; *a*, apron (domilâ); *g*, gate (pamuerta); *m*, mouth (pamuerta); *w*, wing (pamakô); *bh*, big heart (ligao); *el*, elbow (pagsiko); *sh*, small heart (sagaran); *tp*, terminal pound (bonu-an).

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during the lowest tide, the idea being to provide live wells in which to hold the fish alive while awaiting buyers. Before the tide rises a portion of each wing next to the first compartment is walled with banata. At the slack of the high tide all openings along the wings are completely fenced with the bamboo mattings. This work is done with all possible haste, and the fishermen use two bancas or two rafts to carry all the necessary material and equipment for the purpose. The pahubas is now fully set and the men await the low water. As the tide drops the fish within start moving outward, and when the water has left the tidal area they finally find themselves prisoners in the compartments. To hurry the movement of the fish into the collectors the fishermen beat the water inside the wings and seine the area with banata thereby herding the fish into the live wells. The catch is sold on the spot, taken to the markets, or held alive for better prices. If it is intended to continue fishing in the same place, the screens on the wings are unfastened and left to lie on the ground to be raised and put in position again at the slack of the following high tide. Generally, however, only one attempt is made at one place. This method of fishing is well adapted to gradually sloping seashores, especially during the months when the tide is high and the weather good.

TANGCUP

Localities.—Throughout the western Visayan region and elsewhere.

Fishes caught.—All kinds of shore fishes, prawns, shrimps, and crabs.

Description.—The *tangcup* is essentially a small edition of the pahubas, having all the features of the latter except the extent of the runners or wings (pamakô), which are proportionately shorter. Its principal parts are the two wings, the primary heart (ligao), the secondary heart (sagaran), and the terminal collecting chamber (bonu-an), which are generally deeper than those of the pahubas. The bamboo matting for walls is constructed in the usual manner; that is, a number of finely-smoothed splints of the desired size and length are held together in parallel order at regular intervals by a number of parallel lines of hagnaya or rattan lacings to form a section (banata) that can be rolled like a porch screen. For each part of the tangcup there is a definite number of sections or pieces, which are from 4 to 7 meters in length and vary in depth ac-

cording to where they are used. The collecting compartment has always the deepest banata, and the wings have the shallowest since they are extended towards the shore. The mesh of the banata varies from 10 to 50 millimeters. The stakes, driven firmly into the ground 50 to 100 centimeters apart and arranged according to the plan, are strengthened by braces so that the whole structure is a more or less rigid framework supporting the walls of bamboo matting. As in the other kinds of fish corrals the upper extremities of the banata rise about a meter above the highest level of the tide.

Method of use.—The tangcup is generally set in the shallow water along the shores of inclosed bays and rivers, with the runners opening seawards; it may also be located in lakes where its operation is generally continuous throughout the year. A crew of from two to four persons working from an outrigger dugout is sufficient to operate a tangcup of average size. As in the tulis, the fore compartments are seined with banata to deposit the fish in the terminal chamber. This is also seined to impound the fish in one corner in a live well, about a meter in diameter, from which they are finally brailed out with a dip basket or sihud. The catch is generally poured into large bamboo baskets in which it is transported to the shore.

SAPLAD

Locality.—San Jose de Buenavista, Antique.

Fishes caught.—Bañgos fry (awa-awa).

Description.—The *saplad* (Plate 6, fig. 2) is a set trap consisting of two parts; namely, the runners or fences and the rectangular net called "saplad," the name adopted for the whole device. The walling for the fences is of crushed bamboo (*tinidtid*), and the net is made up of from three or four pieces of salap, sewn, hemmed, and strengthened with abacá twine. The linear extensions or wings are generally not over 1.5 meters in depth, but vary in length according to the area to be inclosed. The saplad proper is about 3 meters long and 2 meters wide. Bamboo and wooden stakes or poles constitute the material for supports and braces.

Method of use.—The saplad is set in water up to about a meter in depth and may cover the entire width or only a section of an estuary or tidal creek, with the runners or wings both arising from a common point and diverging like the letter V towards the sea. The bamboo wall, or tinidtid, which is sup-

ported upon a number of stakes firmly driven into the ground at regular intervals, rests on the bottom throughout its entire extent. Pieces of salap are hung upon the inner side of each wall to further insure the catching of the tiny fish entering the inclosure. At the point where the walls diverge there is a narrow gate for the fish to pass through into the rectangular collecting net that is suspended along the longer borders from two bamboo frames supported by four uprights. The longer borders and the margin opposite the narrow gate are well above the water so that the net is converted into a shallow suspended bag. The fry going up stream during the incoming tide are eventually caught in the bag, from which they are dipped by means of a white enamelled basin (*palanggana*). This kind of basin is extensively used in bañgos-fry fishing because of its whiteness, which makes it easy to see the small fish contained in it, and because it is more convenient and more durable than most any other object that can be used for the same purpose. From the basin the fry are poured into earthen jars in which they are kept and transported.

SIRA

Locality.—Negros.

Fishes caught.—Young mullet (gusao), siganids (dangit, samaral), *Therapon* (*bagaong*), grouper (inid), crustaceans (pasayan, locon, and alimañgo), and a great variety of other marine fishes.

Description.—A complete outfit of *sira* or *lapac* consists of two or more large dugouts, a large number of units of bamboo screens, and numerous stakes. The dugouts are employed to carry the screens and stakes from one place to another. The screens are closely woven and measure about 2 meters in depth and from 3 to 5 meters long. Usually the stakes are made of *bakhao*. Like the pahubas, the sira is a temporary bamboo corral set along the edges of mudflats and swamps to catch fish frequenting the intertidal zones.

Method of operation.—As in the pahubas, the stakes are set during the lowest tide in order to facilitate the work and to locate easily the proper positions of the pounds and walls. The screens, which have been rolled up, are also fastened to these stakes at regular intervals. As many units of bamboo screens are used as are necessary to complete the inclosure so that the ends may be located at high places or against fishpond dikes.

A few minutes before the highest tide, the screens are laid out with all possible haste and every care is exercised that no opening is left unclosed. Pounds are set out at intervals and are usually located in creeks. The gear when fully set is nothing but a long inclosure or fence formed by the different units of banatas fastened to stakes, and laid around an extensive area of mud flats or swamps. As the tide recedes the fish within start moving outward and when the water has left the tidal area they finally find themselves confined in the pounds. Not all the fish, however, are caught in the pounds. A considerable number may be taken by the fishermen with their bare hands along the sides inside the inclosure.

COST OF CONSTRUCTING A FISH CORRAL

The cost of constructing a fish corral depends primarily upon its style, size, and the depth of the water where it is to be set. A simple type of ordinary dimensions located in water from 7 to 10 meters deep may cost anywhere from one to two thousand pesos, and a more pretentious structure set in water about 25 meters deep may cost as high as 8,000 pesos. A hasang moderno set in water about 15 meters deep would cost no less than 3,000 pesos. The items that usually enter into the expense account are as follows:

	Pesos.
Materials and equipment:	
100 anahaw poles	1,000
1,500 bamboo poles	900
15,000 rattan or balâbâ	200
10,000 hagnaya	100
1 banca	250
1 cotton seine (sigin), second hand	300
Labor:	
Contract for preparing all materials; that is, splitting and smoothing of bamboo and rattan and weaving of sections or banata	300
Wages for setting fish corral	300
Miscellaneous:	
Provisions, drinks, cigars, cigarettes, medicines, etc., for laborers and fishermen	100
Total	3,450

LAY OF THE FISHERMEN

In punut fishing, the owner may employ fishermen on a wage basis, each man receiving a daily wage of from 1 to 1.50 pesos. The maestro or headman of the fishermen gets from 2 to 3

pesos a day. These men are not under contract, but they generally pledge themselves voluntarily to work for one employer for one fishing season. If the fishermen work under a share basis the usual arrangement is as follows: The owner of the fish corral takes one-third of the daily proceeds and the crew as a whole receives the two-thirds to be divided among the members, including the maestro. The latter gets 5 per cent of the owner's share in addition to his own share from the two-thirds. Or, the proceeds are divided into halves, one-half going to the owner and the other half to the crew, the maestro receiving his usual 5 per cent of the owner's share besides. There are several other arrangements among owners and fishermen, but they are gradually becoming obsolete. One of these is that the total cost of the fish corral is deducted from the gross income first; two-thirds of the balance go to the crew to be divided equally among themselves; the remaining third goes to the owner. Under this arrangement, the owner is required to provide for the necessary maintenance of the families of his men during the fishing season. The accounts are settled at the end of each fishing period.

BOATS

BAROTO

Localities.—Throughout the Visayan region.

Description.—The *baroto* (Plate 7, fig. 1) is a canoelike boat hollowed out generally from the trunk of a red *laua-an* tree (*Shorea negrosensis* Foxw.). When properly made it is of graceful slender proportions with a more or less flat bottom. Its bow turns up gradually from the water line and extends gracefully forward in an overhanging effect. The stern runs out in the same manner only not so boldly and not so extended, with the result that it appears rather slenderer and closer to the surface of the water than it actually is. The bottom is about 2 centimeters thick; the sides are 1 centimeter in thickness. This dugout is invariably fitted with outriggers made by laying out two long slender poles of bamboo or wood across the rim at some distance from each end of the boat and so arranged that the extreme ends of each pole extend equidistantly from the center of the craft. Each crosspole is lashed by rattan or twine to a crosspiece at the bottom below the point where the pole crosses the rim. There are two outrigger floats of light saplings or bamboo; each of these is lashed by cross-seizings of rattan which are worked all round each float

or through a hole in it to the underside of the pole at the extreme end so that each float lies parallel to the boat. The floats give the dugout the necessary balance and stability to make it seaworthy, especially when rigged with sails. The seats are made of wooden planks placed across the width of the boat. The paddles are of red laua-an or molave (*Vitex parviflora* Juss.), and each has a long slender handle and oblong blade.

The baroto varies greatly in size from a one-person dugout to one accommodating ten persons. An ordinary one-person boat measures about 4 meters in length, about 40 centimeters in greatest beam, and about 50 centimeters in depth.

There are three distinct variations in the construction of dugouts classed as baroto. A baroto for passengers and cargo such as the *bankerohan* or ferryboat across streams is more flattened on the bottom, wider in beam, and more heavily built. This is usually provided with outriggers. A boat for cargo alone is built with still wider beam and thicker bottom and sides and carries no outriggers. The baroto for fishing is narrow with a high sharp cutwater and is very light afloat. Boats of this type are the *ondaon, panagatan,* and *sibidsibiran,* which are built primarily for speed. Each of these three types is usually made out of one piece of wood; however, the panagatan and sibidsibiran may also be constructed in the following manner: A small dugout is prepared first. It is generally made narrower than the usual type so as to serve as the keel. The end of the stem post is cut into a scarf joint in which the cutwater is fitted; likewise, the stern post is scarf-jointed with the overhanging flank of the stern. Along the rim of the dugout are built supports and framework to which the necessary parts are attached. The side walls made of bamboo matting (*amakan* or *sawali*) are fastened to the supports with stout cotton twine. A sticky white pitch (*alquetran*) is painted on the outer and inner surface of the sawali to make it waterproof. The seams and cracks are caulked with white pitch mixed with coconut coir. Wooden nails, or pegs, are extensively used. The other details of construction are difficult to describe in words.

Use.—The baroto is unquestionably the most indispensable of equipment and is popularly used through the Visayan region in fishing and in transporting cargo and man. On the coasts it is primarily employed in hand-line fishing and around the fish corrals; in the rivers and lakes it is used largely for transportation but also for fishing. In managing the baroto, sculling

from the stern is the usual method. The man may sit or squat facing the bow while working the paddle on either side. Besides the paddle, a square-cut or triangular sail is also employed to furnish motive power. The baroto is occasionally managed by a push pole, which is thrust obliquely to the bottom from the stern or bow. Whenever necessary oars are used to propel it.

BANCA

The term "banca" is given to dugouts or built-up boats that are larger than the baroto and panagatan and invariably includes the bankerohan of at least 5 meters' length. The commonly known bancas are the *chinchorrohan*, *sapiaowan*, *dinalapang*, and *boteng pamunuanan*. This classification is arbitrary, for it is based mainly upon the use to which each is put, and the type of construction is but little considered as a criterion. For, in fact, any of these four boats may be called by any other name depending solely upon the purpose for which it is used. Thus, the boat employed in the operation of the chinchorro is called "chinchorrohan;" the one used in the working of the sapiao, the "sapiaowan;" and that which serves as the conveyor of the crew to the fish corral as well as the load boat for the catch is termed "pamunuanan." The last designation is so inclusive as to mean even a row boat, provided it is used as equipment in fish-corral fishing.

The four bancas mentioned vary but slightly in style of construction; that is, they are all canoelike with the bow and stern turned up in a graceful overhanging fashion from the waterline to the narrow ends and all have a sufficiently hollow or concave floor and fairly good bilge enabling them to float quite steadily without the aid of outriggers, although usually they are fitted with these accessories to render them more seaworthy or more manageable. The motive power for bancas is supplied by paddles or oars. Auxiliary sails are often used when the wind is favorable. These boats are built for cargo and run speedily.

CHINCHORROHAN

Localities.—All around the coasts of Iloilo, Capiz, Negros, and Cebu.

Description.—The chinchorrohan (Plate 8, fig. 1, and Plate 9, fig. 1) is "modeled" and not designed, having for its basic principle of construction the typical one-piece baroto; but it is larger in size and more graceful in sheer. Its bow and stern turn up from the water line and run beautifully to a narrow

end and it has a more overhanging effect and bolder bilge than the baroto. The banca is full bodied above the water and draws a light draft. It may be fitted with outriggers, which are arranged in the manner already described. A typical chinchorrohan has from ten to fourteen seats made of wooden thwarts. The paddles are long handled with narrow oblong blades. When oars are used they are tied loosely to a pole placed parallel with each side of the boat, or to oarpins fitted into the pinholes on the rims. The steersman uses a larger paddle or a longer oar.

Use.—As the name implies, this banca is used in the operation of the chinchorro (bitana or baling). It is run by paddlers or oarsman and is capable of fast movement, a requisite for the kind of fishing in which it is employed. It is oftentimes equipped with an auxiliary sail.

SAPIAOWAN

Localities.—Estancia, Iloilo; Cadiz, Occidental Negros; and Capiz, Capiz.

Description.—The sapiaowan (Plate 8, fig. 2) is a departure from the usual V-shaped dugout but retains the overhanging effect of the bow and stern, which are practically alike in form although the former has a bolder appearance than the latter. The prow and stern ends are triangularly cut. It is full bodied above the water; the bottom is flat, with the sides rising almost like a U; the sheer is graceful, increasing forward and backward to a bow shape; the boat draws a light draft. It has no outriggers but is stable on the water. Its equipment consists of fourteen good-sized paddles and one large one for the steersman. There are seven wooden thwarts for seats.

Use.—This is a typical banca used in the operation of the sapiao as well as the other large seines with which the round-haul method is employed in catching fishes that run in shoals. It is also utilized in corral fishing.

DINALAPANG

Localities.—Sicaba, Cadiz, Occidental Negros.

Description.—The dinalapang (Plate 10, fig. 1) is a flat-bottomed dugout shaped like the sapiaowan but with the stern and prow ends rounded instead of triangular. It is provided with a rudder, the horn of which is inserted through a center hole in the stern; the rudder is moved by a tiller. There are wooden thwarts for the ten oarsmen. The oars are slender, with narrow

oblong square-ended blades, and are attached to pins on the rims by means of a stout twine.

Use.—The dinalapang is generally used in connection with fish-corral fishing, but it is also employed in the operation of large nets; such as, the kubkub, pukot, and chinchorro, as well as a general utility boat for cargo and passengers along the coasts and in rivers.

BOTENG PAMUNUANAN

Localities.—Cadiz, Occidental Negros, and elsewhere.

Description.—The boteng pamunuanan (Plate 10, fig. 2) is a boat hollowed out of a large red laua-an trunk, as are the baroto and banca, but it is modeled after the modern row boat. The stem is straight above the water line and curved below; the bow has a moderate flare. The stern has a graceful run and is square-cut at the end. The sternpost is straight, making a right angle with the keel. The rudder is hung outside and moved with a tiller; it swings on two L-shaped iron pins or pintles through the two screw eyes on the stern. The bote is usually provided with wooden thwarts for the oarsmen or paddlers. The oars are similar to those used in dinalapang.

Use.—This boat can be used for almost any purpose. In Cadiz its use in the operation of fish corrals is becoming more popular. Hence, where most of the fish traps are located near the shore, the bote has been found very convenient. It can be much more easily maneuvered than the long slender banca; it carries as much load as does a banca twice its length, and it is more stable on the water than any banca without outriggers. The motive power is supplied by the five oarsmen or ten paddlers. Often the bote is rigged with a square-cut sail. Lately this boat has been found satisfactory in the operation of seines such as the kubkub and pukot for sardines (tamban). It is an indispensable equipment of any large sailing boat in the Visayan region. In some places, it is motored and used to tow bancas and other similar craft.

SIBIDSIBIRAN OR PINANYO

Localities.—Estancia, Iloilo; Sicaba. Cadiz, Escalante, San Carlos, Occidental Negros; Bantayan, Barili, Cebu.

Description.—The *sibidsibiran*, or *pinanyo* (Plate 11, fig. 1) is usually a one-man dugout or a built-up panagatan with sawali (amakan) sidewalls placed in the manner previously described. It is equipped with wide-spread outriggers and is rigged with a

handkerchief-shaped sail, hence the name pinanyo. It carries a rudder which is worked on a rudderstand at the right side of the stern immediately behind the cross pole of the outriggers. One of its most necessary equipments is a large paddle for sculling or steering, particularly during a calm or a light wind.

Use.—This is a typical boat in long-line fishing and in trolling or sibidsibid, hence the name "sibidsibiran." Owing to its narrow body and sharp bow and its comparatively large sail spread, the pinanyo is capable of making good speed under a spanking breeze. Its speed is suited for trolling. In shallow channels or stretches between small islands or coral reefs where the water is more or less turbulent, or in the deeper water adjacent to favorable fishing grounds, a number of sibidsibiran may be seen most any time trolling for barracuda, tañgigi, or sharks. When trolling is not favorable the boat is used in handline fishing or in hauling up portable fish traps (bobo).

BILUS

Localities.—All round the coasts of Iloilo, Capiz, Occidental Negros, and Oriental Negros.

Description.—The *bilus* (Plate 11, fig. 2) is essentially an enlarged built-up sibidsibiran equipped with a large mainsail and jib. The large sail resembles the sail of the Italian felucca, except that it is provided with a boom or spar fastened to the foot and a long pole diagonally set with its upper extremity fitted through an "eye" at the apex of the sail and its lower end held in a sling attached to the lower part of the mast. The sail is rove through a hole in the headmast or through a suspended block. The bilus is constructed for speed.

Use.—This craft has a variety of uses, but it is primarily employed in connection with fish-corral fishing. It transports iced fish and fish products and other cargo; it is also widely utilized as a passenger boat.

BALANDRA

Localities.—All round the coasts of the western Visayas.

Description.—The term *balandra* (Plate 12, figs. 1, 2, and 3), is no doubt derived from "bilander" or "belander" which was the name of a two-masted boat having a lateen mainsail, used principally on the canals in some European countries. In the Visayas this name is given to a large bilus. Except for the size, the balandra resembles closely its prototype, in form and in rigging. This type is built also for speed.

Use.—The balandra has the same general utility as the bilus. Because of its speed, it is generally used in carrying fresh fish for long distances. During a successful sardine season in Estancia a large number of balandra ply between this fishing center and Cadiz and other northern towns of Occidental Negros.

PARAO

Localities.—All round the coasts of Iloilo, Capiz, Occidental Negros, and Oriental Negros.

Description.—The *parao* (Plate 13, fig. 1) is a large balandra rigged with two masts stepped in the bottom of the boat and held on deck by stocks. It has a fairly long bowsprit to increase the size of the jib, and is equipped with four outrigger crosspieces, the middle two of which are placed close to each other. Usually three poles of bamboo or light sapling are lashed to the underside of the extreme ends of the crosspieces to serve as outrigger floats. The sails are of cotton cloth; they vary in cut according to locality, but they closely resemble a cutter's mainsail. Booms are attached to the upper and lower edges of the large sails; the upper booms are raised by means of block and tackle. The rudder is similar to that of the balandra.

Use.—The parao is a craft of general utility in the Visayan region. It is used for transporting general cargo and fish products as well as passengers.

BINABAENG PARAO

Localities.—On the coasts of Iloilo and Occidental Negros.

Description.—The *binabaeng parao* (Plate 13, fig. 2) is of the same stamp as the preceding, although its sheer is more graceful than that of the parao and its prow is more obliquely curved; but like the parao, its bilge is slightly flared; that is, with a full dead rise. This type differs from the parao in several noticeable features; namely, the stern is slenderer with a more graceful upturn from the water line, the rudder is of the center type having a tiller moved by block and tackle, and the stern end is rounded. The rig is the same as that of the parao.

Use.—The binabaeng parao is used extensively for cargo and passengers. It transports fish products to be sold in the towns along the coasts of the Visayan seas.

KUDASTRE

Localities.—Along the coasts of the western Visayan islands.

Description.—The *kudastre* (Plate 14, figs. 1 and 2) is a two-masted boat constructed on the same general plan as the two

preceding types. It resembles more closely the binabaeng parao than it does the parao. Its most characteristic feature is its heavy build. The rig is the same as that of the other two.

Use.—Because of its heavy construction the kudastre is used primarily for cargo. It is usually laden with fish products to be transported to distant places.

TINABLA

Localities.—Sicaba, Cadiz, Occidental Negros, and elsewhere in the western Visayan islands.

Description.—The *tinabla* (Plate 15, fig. 1) is essentially identical with the preceding type, except the material used in the construction of the waists which consist of wooden planks or boards instead of balustrades. The other details are practically the same as in the kudastre.

Use.—This boat is used for passengers and general cargo. It is capable of extended voyages around the Visayan islands, carrying on trade in fish products, general foodstuffs, and merchandise.

BATIL

Localities.—Along the coasts of Iloilo, Antique, Capiz, and Occidental Negros.

Description.—The *batil* (Plate 15, fig. 2) is of the same general make-up as any of the preceding two-masted outrigger boats. The main feature that distinguishes it from the others is the sameness in shape of stern and prow, the ends of which are cut straight down making practically a right angle with the narrow keel. The rudder, abaft the stern, is hinged vertically by means of eyes and pintles, as previously described in boteng pamunuanan, and is moved by a tiller. The batil is the most heavily built of the sail boats here described. A variation of this type, known as "lorcha" or "palowa" is constructed with a wider beam and a more or less flat bottom and does not require the use of outriggers.

Use.—The batil is used for practically the same purposes as the other large sail boats mentioned above.

ILLUSTRATIONS

PLATE 13

FIG. 1. Model of parao.
2. Model of binabaeng parao.

PLATE 14

FIG. 1. Model of small-sized kudastre.
2. Model of large kudastre.

PLATE 15

FIG. 1. Model of tinabla.
2. Model of a type of batil.

TEXT FIGURES

FIG. 1. Diagrammatic sketch of hudhud; *b*, bamboo crosspiece (kayauan); *f*, float (patao); *h*, handle (kalaptan); *p*, pocket (púyo); *sn*, salap netting; *wp*, wooden peg (tunung); *wr*, wooden runner (sapatos).

2. Diagrammatic sketch of patigbi; *f*, float (patao); *bf*, bamboo float (patao); *fc*, float cord; *fr*, foot rope (lapacan); *lr*, lower rope; *pc*, piece of coconut husk; *sl*, scare line (sagiwsiw labay or tabúg); *st*, seizing twine; *ur*, upper rope.

3. Diagrammatic sketch of surambao; *b*, bamboo frame; *cl*, coco-palm leaves (lukay); *fb*, fish box; *sl*, scare line (tabúg or lukay).

4. Diagrammatic sketch of kayagkag, or anod; *f*, float (patao); *s*, spear (sibat); *p*, plunger (tumbuk); *fc*, float cord; *mc*, marginal cord (halughug); *ur*, upper rope.

5. Diagrammatic sketch of pukot; *f*, float (patao); *s*, single selvage (sadsaran); *fc*, float cord; *lr*, lower rope; *sw*, shell weight; *ur*, upper rope.

6. Diagrammatic sketch of locon-locon; *a*, abacá fiber; *b*, yellow beads; *h*, hooks, top view; *l*, lead weight; *tl*, towline.

7. Diagram of tulis; *a*, apron (domilâ); *el*, elbow (pagsiko); *g*, gate (pamuerta); *h'*, first heart (ligao dakû); *h"*, second heart (ligao diutay); *h'"*, third heart (sagaran); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *tp*, terminal pound (bonu-an).

8. Diagram of linatî; *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *lp*, landing platform (salyadahan); *si*, semicircular inclosure, or main body (bulon).

9. Diagram of inangcla; *a*, apron (domilâ); *el*, elbow (pagsiko); *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *si*, semicircular inclosure (bulon); *tc*, triangular compartment (sagaran); *tp*, terminal pound (bonu-an).

10. Diagram of hasang simple; *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *cp*, collecting pound (sagaran); *lp*, landing platform (salyadahan); *si*, semicircular inclosure (bulon); *sp*, seine platform (kinaban).

FIG. 11. Diagram of hasang antiguo; *a*, apron (domilâ); *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *el*, elbow (pagsiko); *fc*, forechamber (hasang); *si*, semicircular inclosure (bulon); *tc*, triangular compartment (sagaran); *tp*, terminal pound (bonu-an).

12. Diagram of hasang moderno; *a*, apron (domilâ); *g*, gate (pamuerta); *l*, leader (táktakon); *m*, mouth (pamuerta); *w*, wing (pamakô); *el*, elbow (pagsiko); *fc*, forechamber (hasang); *se*, side entrance (pamuerta); *si*, semicircular inclosure (bulon); *sp*, seine platform (kinaban); *sw*, secondary wing (pasalô); *tc*, triangular compartment (sagaran); *tp*, terminal pound (bonu-an).

13. Diagram of pahubas; *a*, apron (domilà); *g*, gate (pamuerta); *m*, mouth (pamuerta); *w*, wing (pamakô); *bh*, big heart (ligao); *el*, elbow (pagsiko); *sh*, small heart (sagaran); *tp*, terminal pound (bonu-an).

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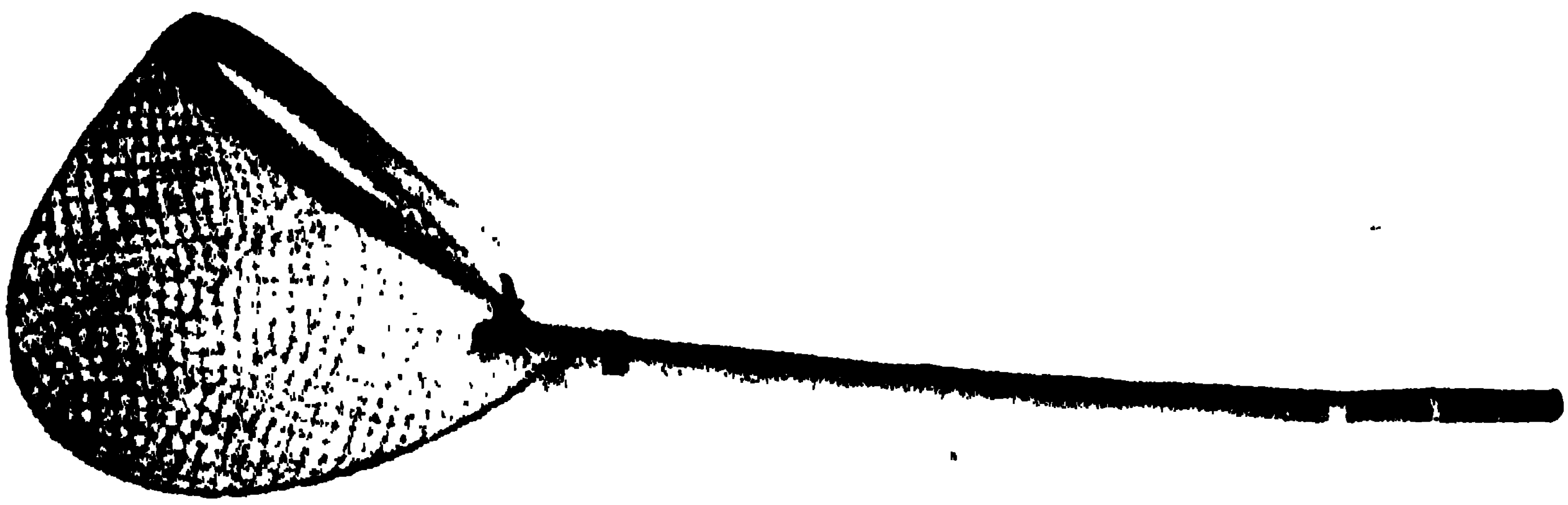

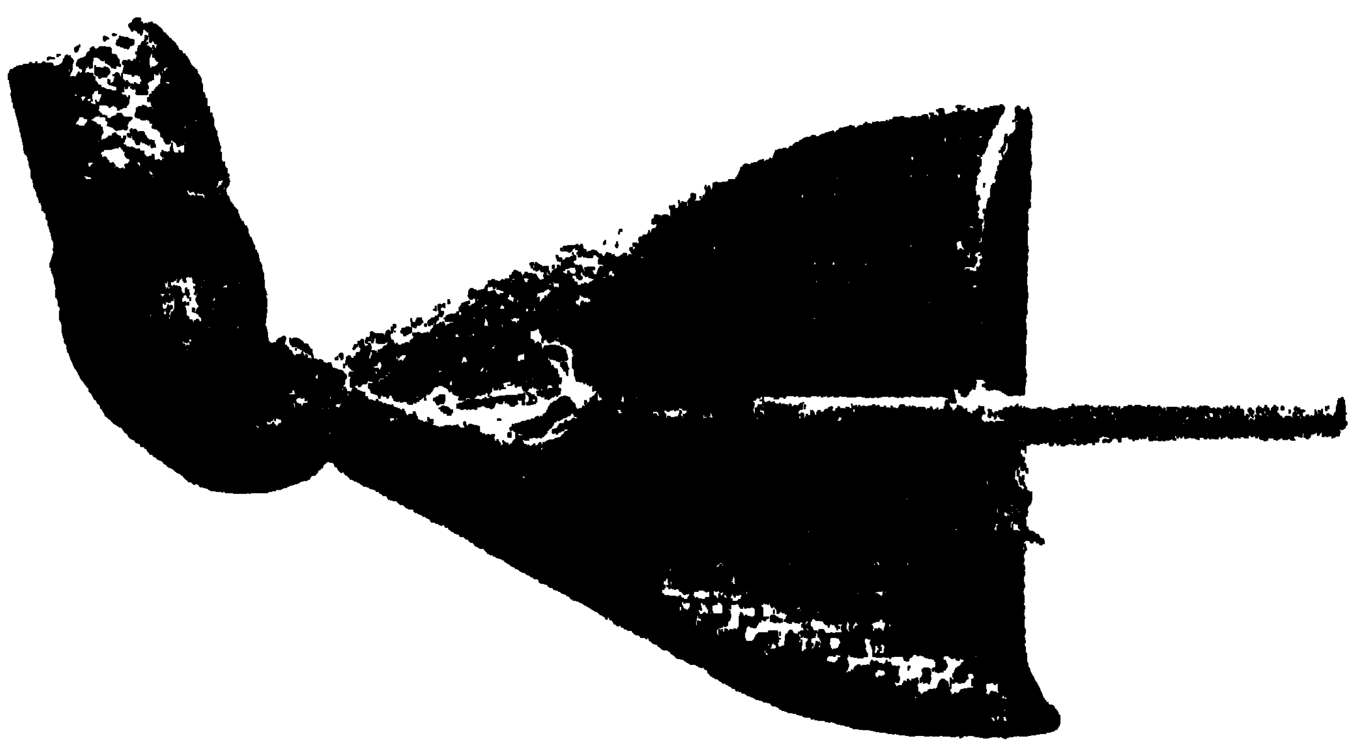

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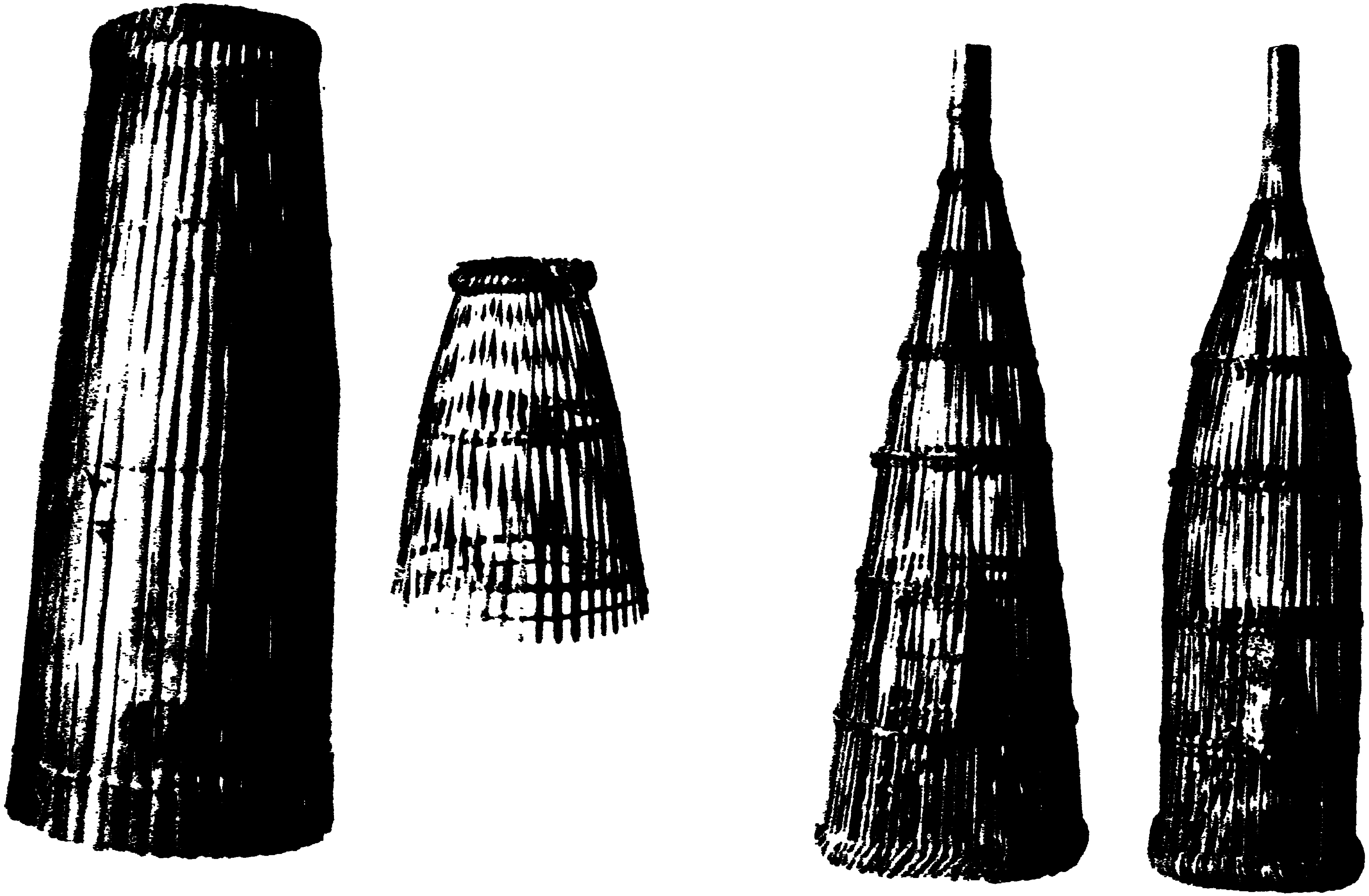

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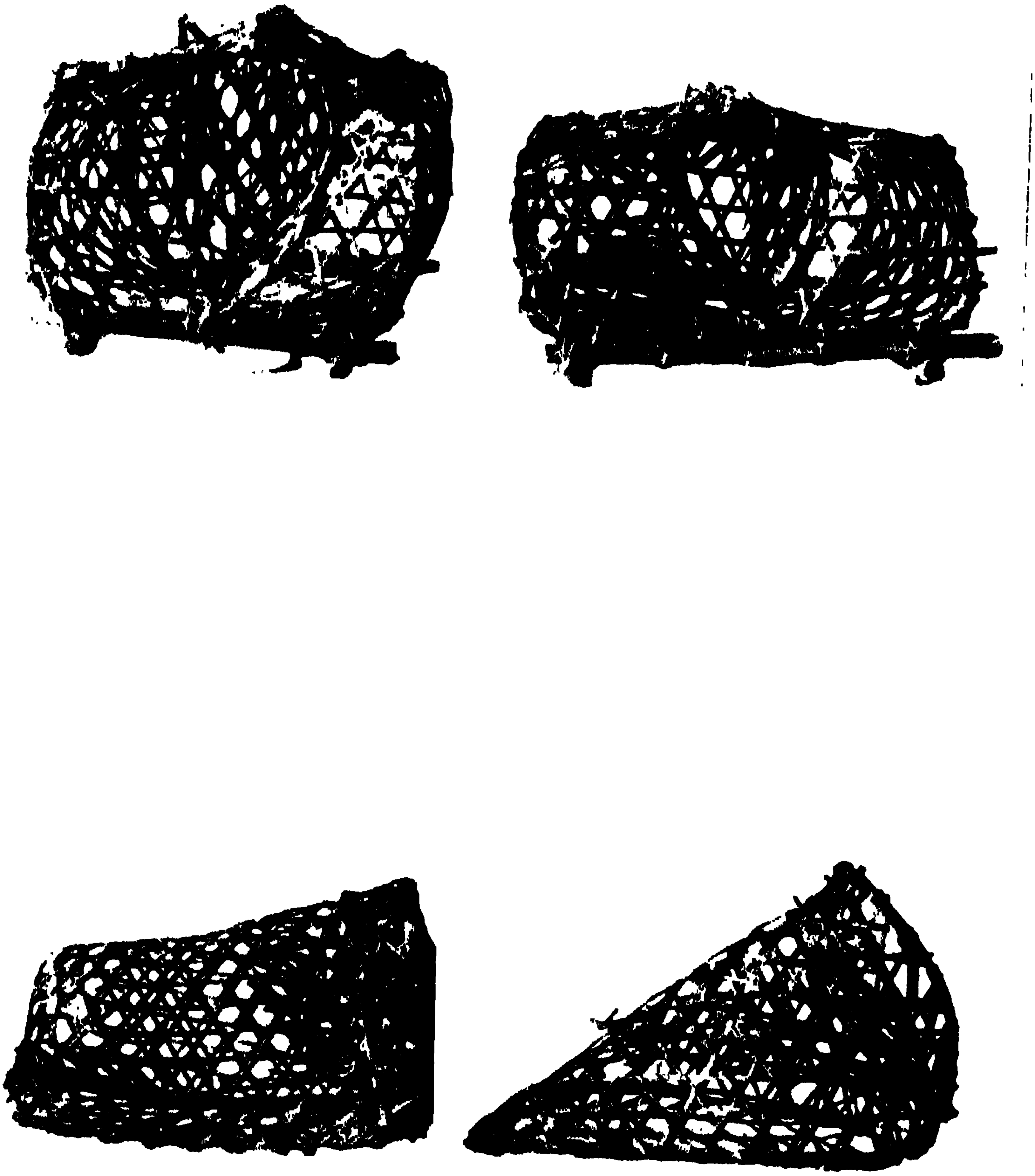

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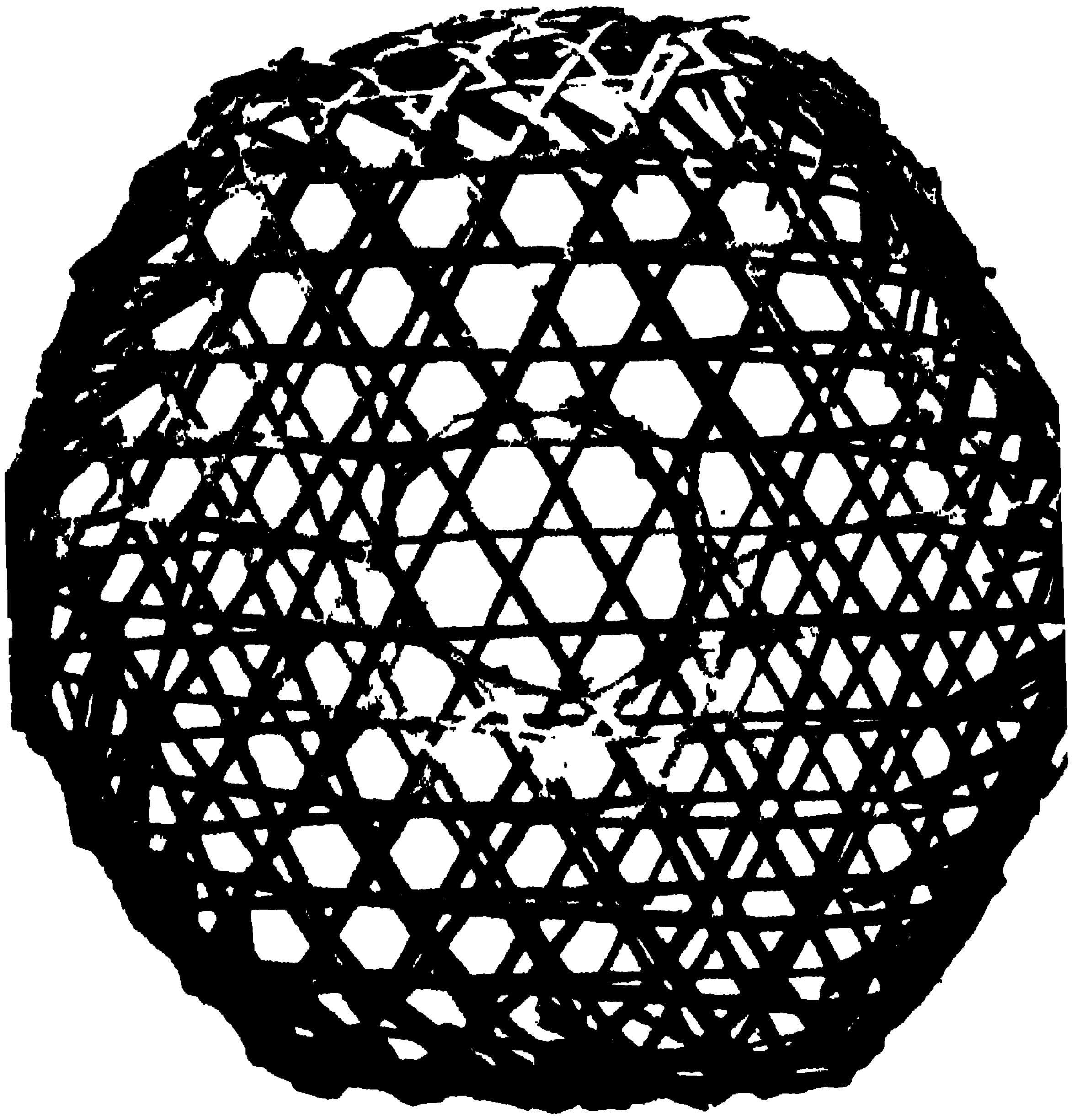

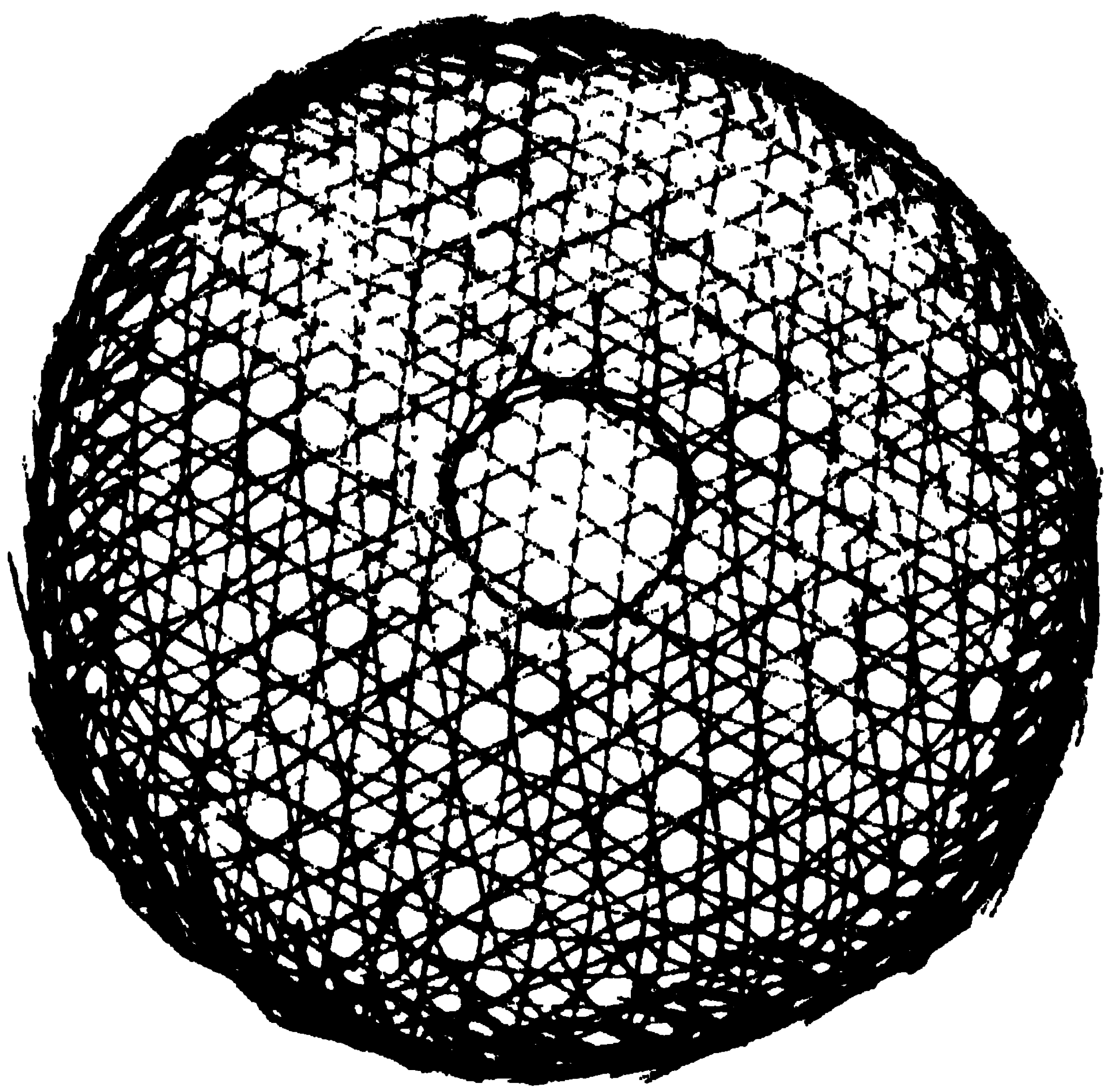

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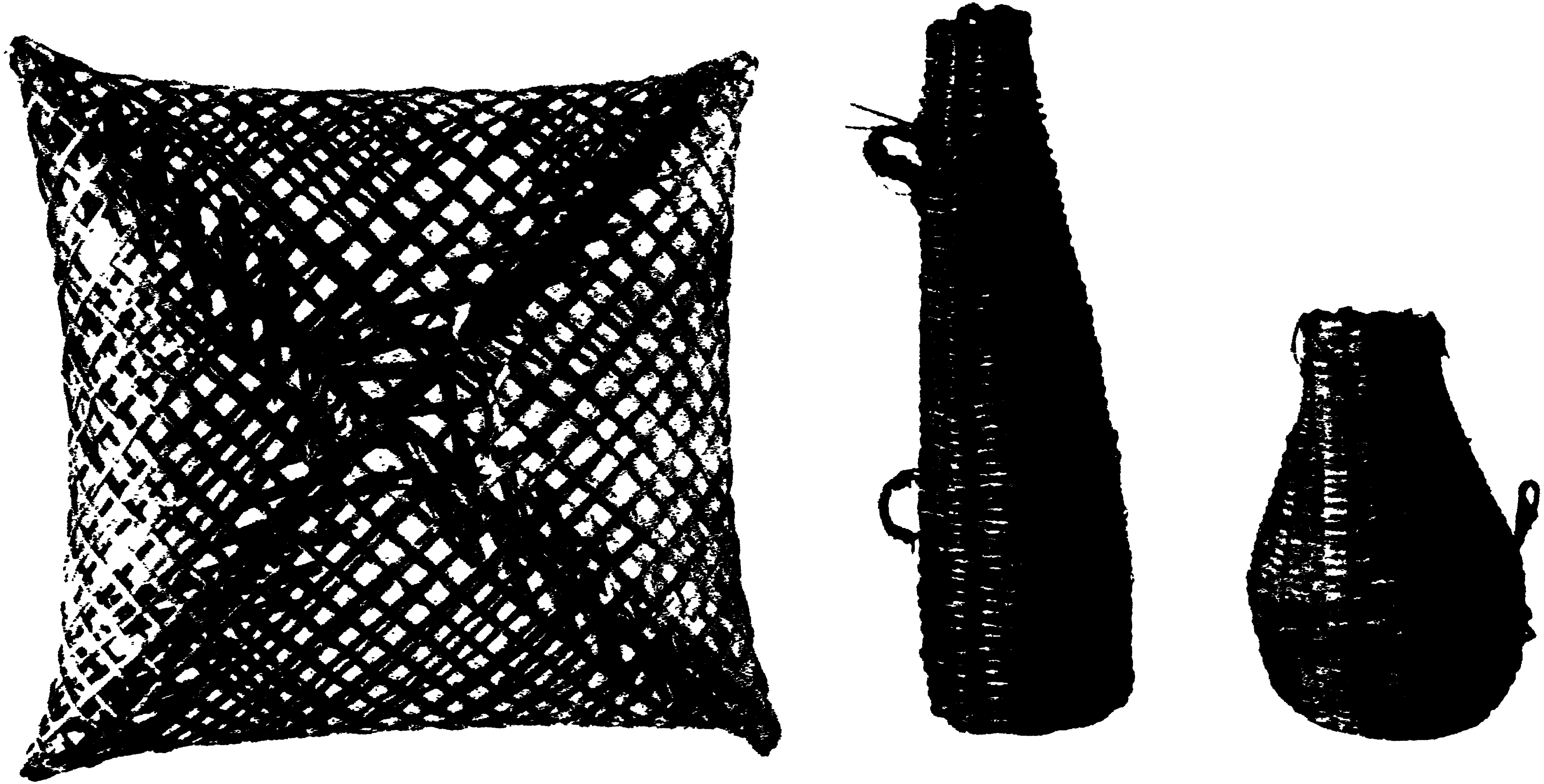

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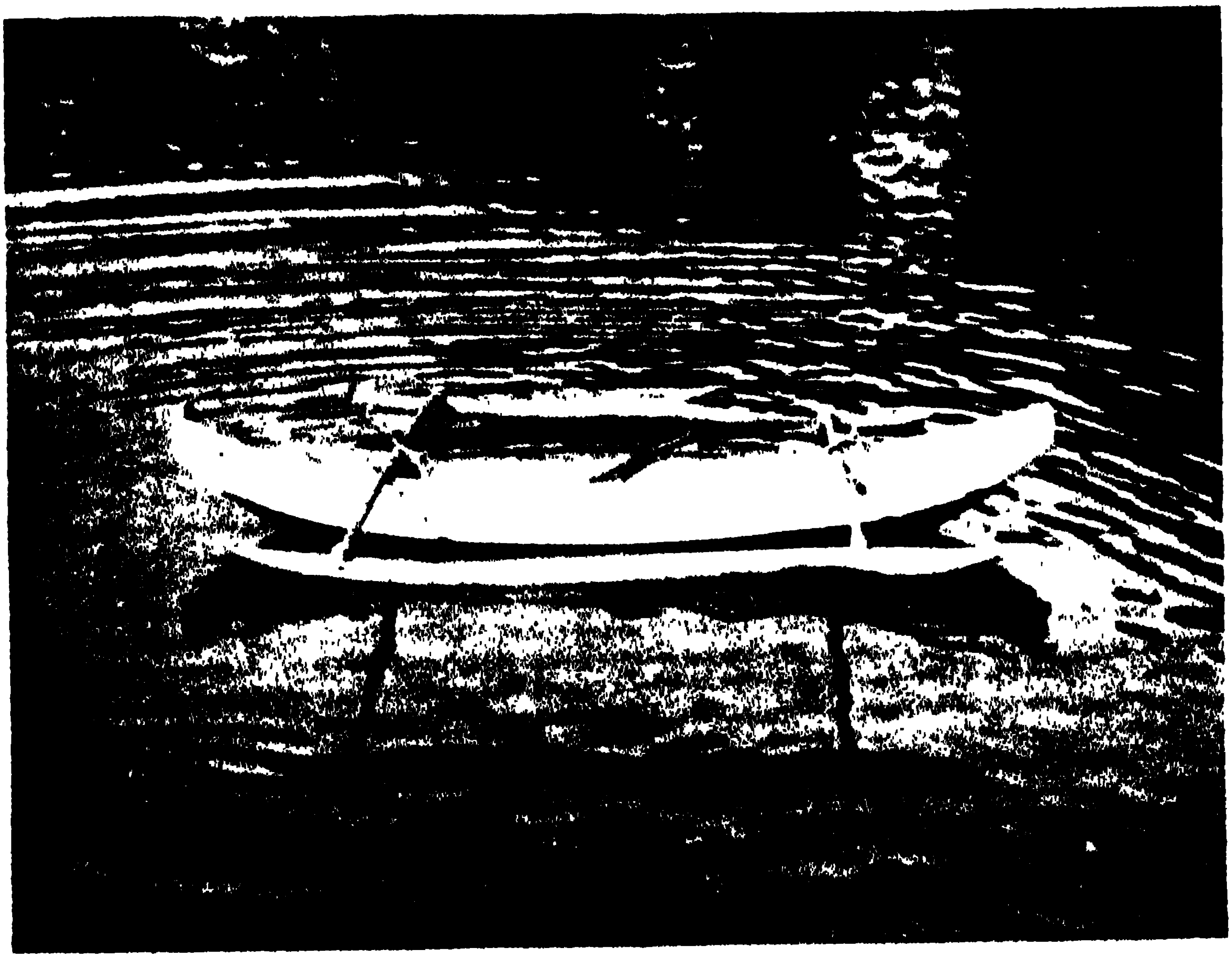

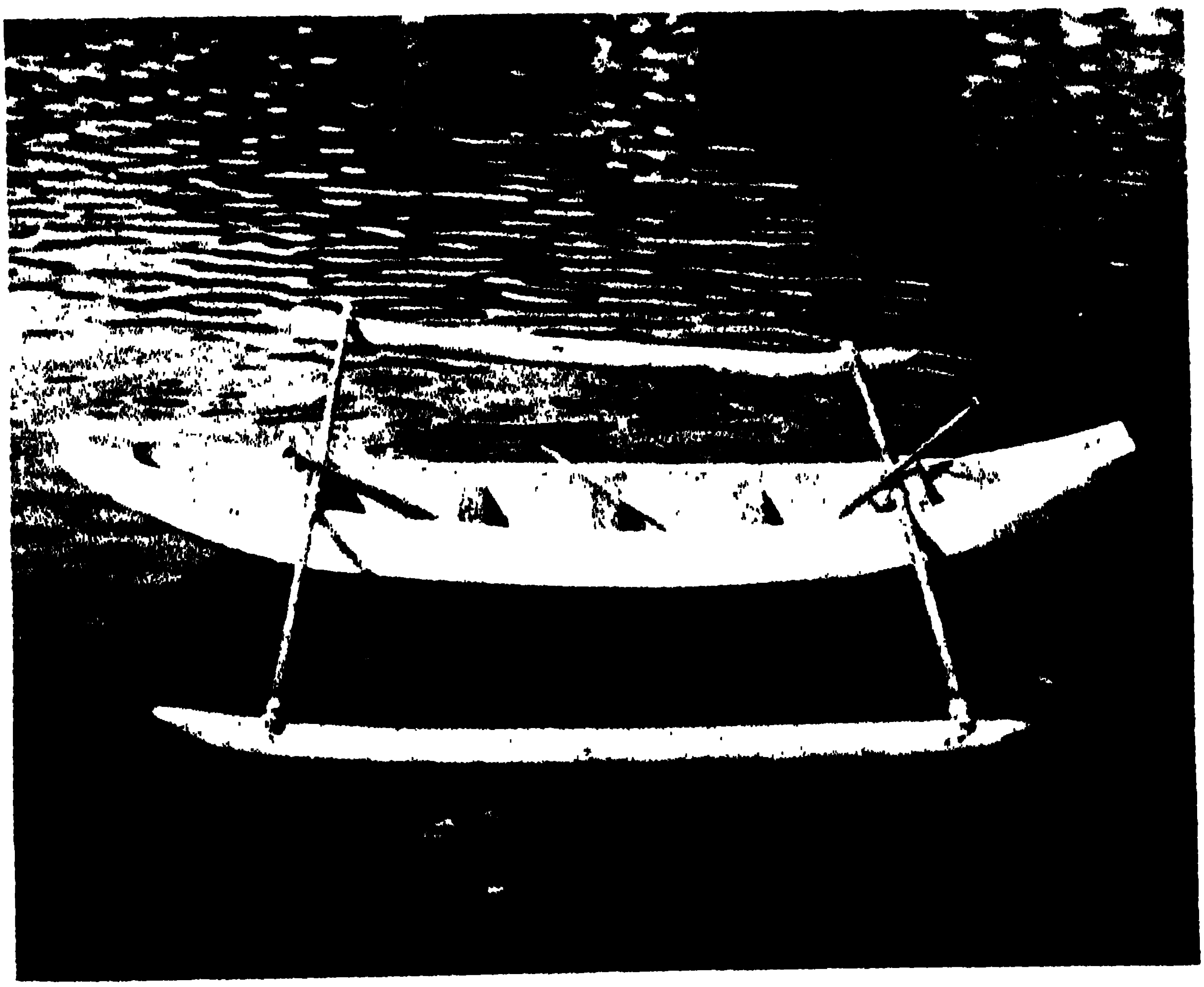

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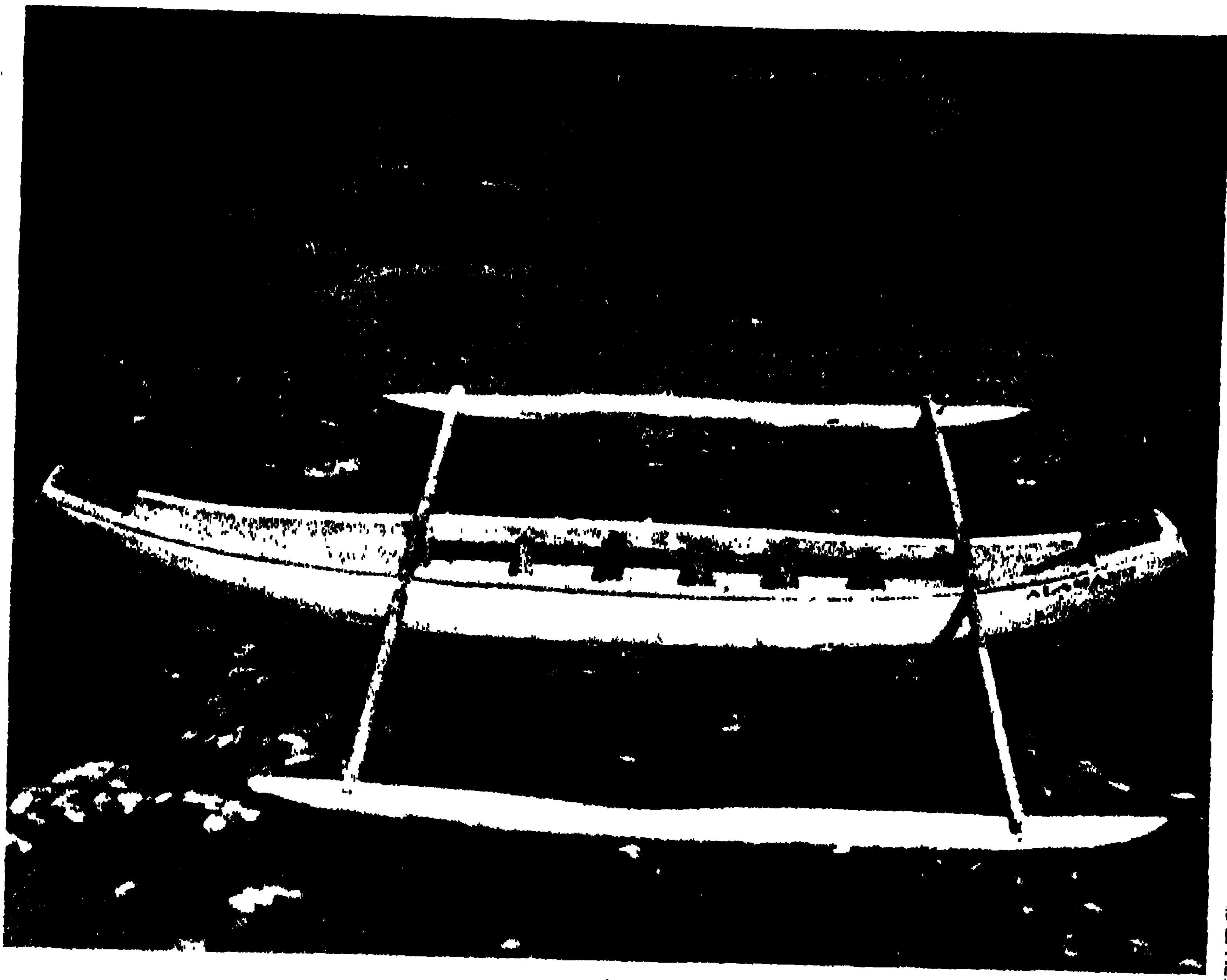

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PLATE 8.

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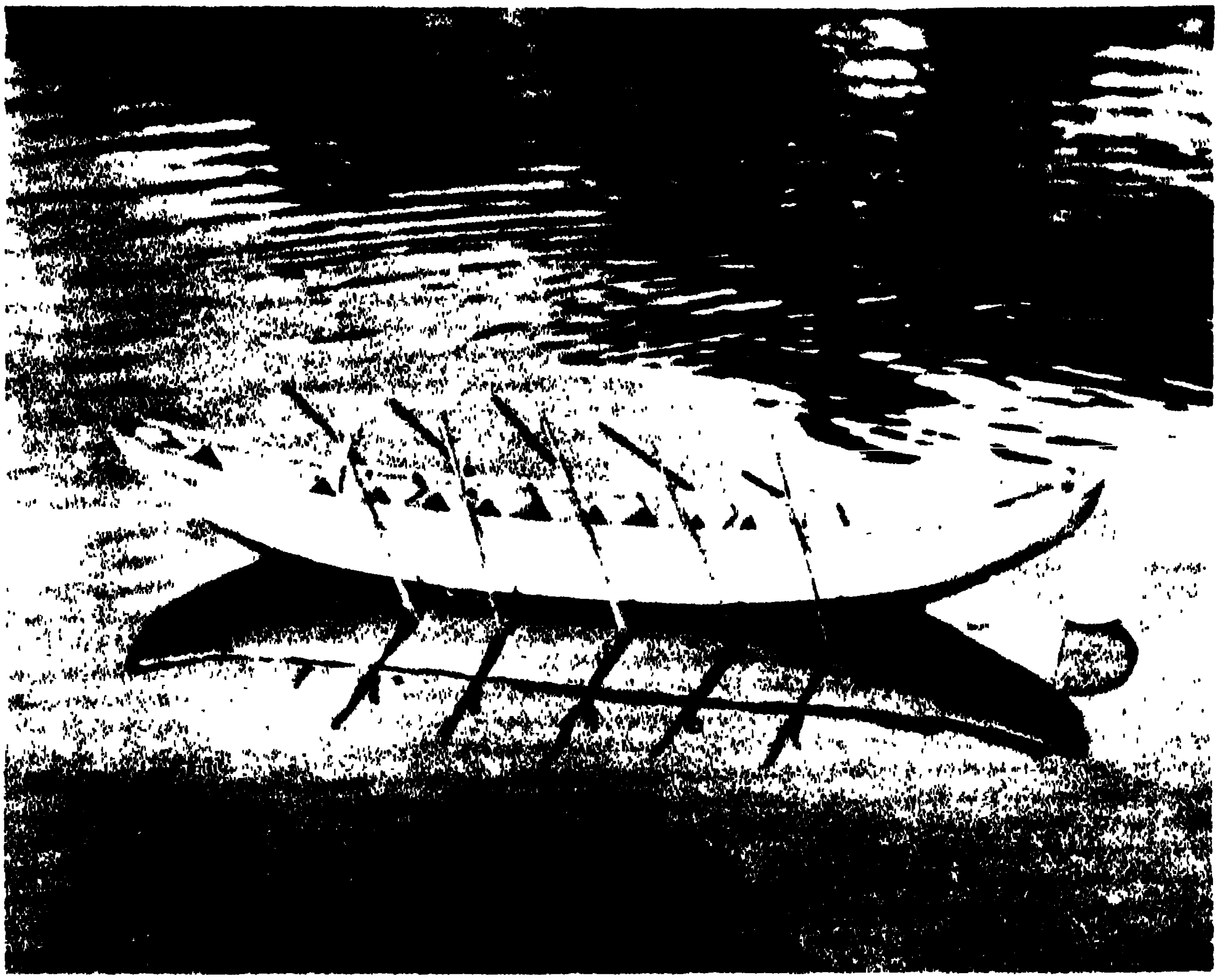
PLATE 9.



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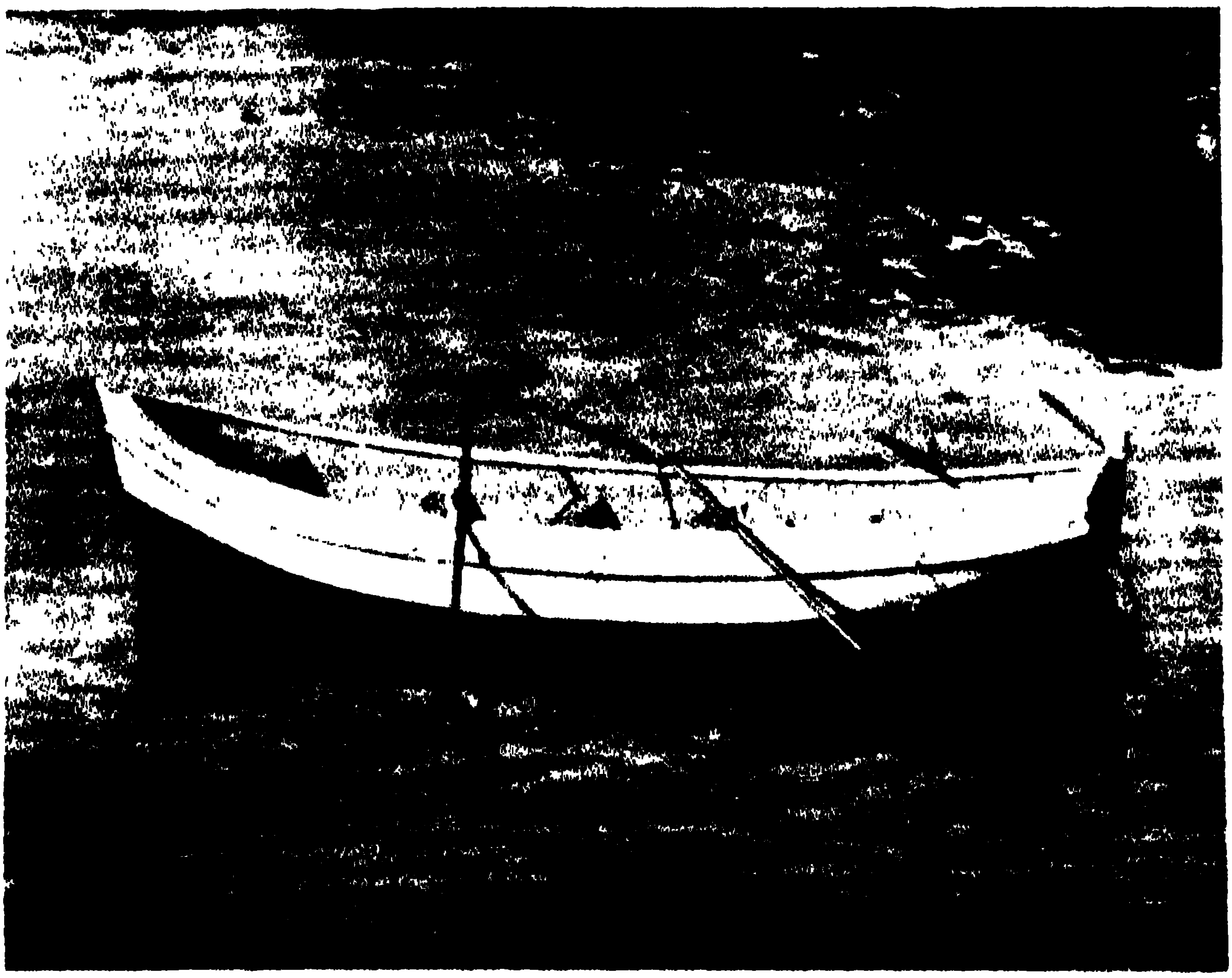

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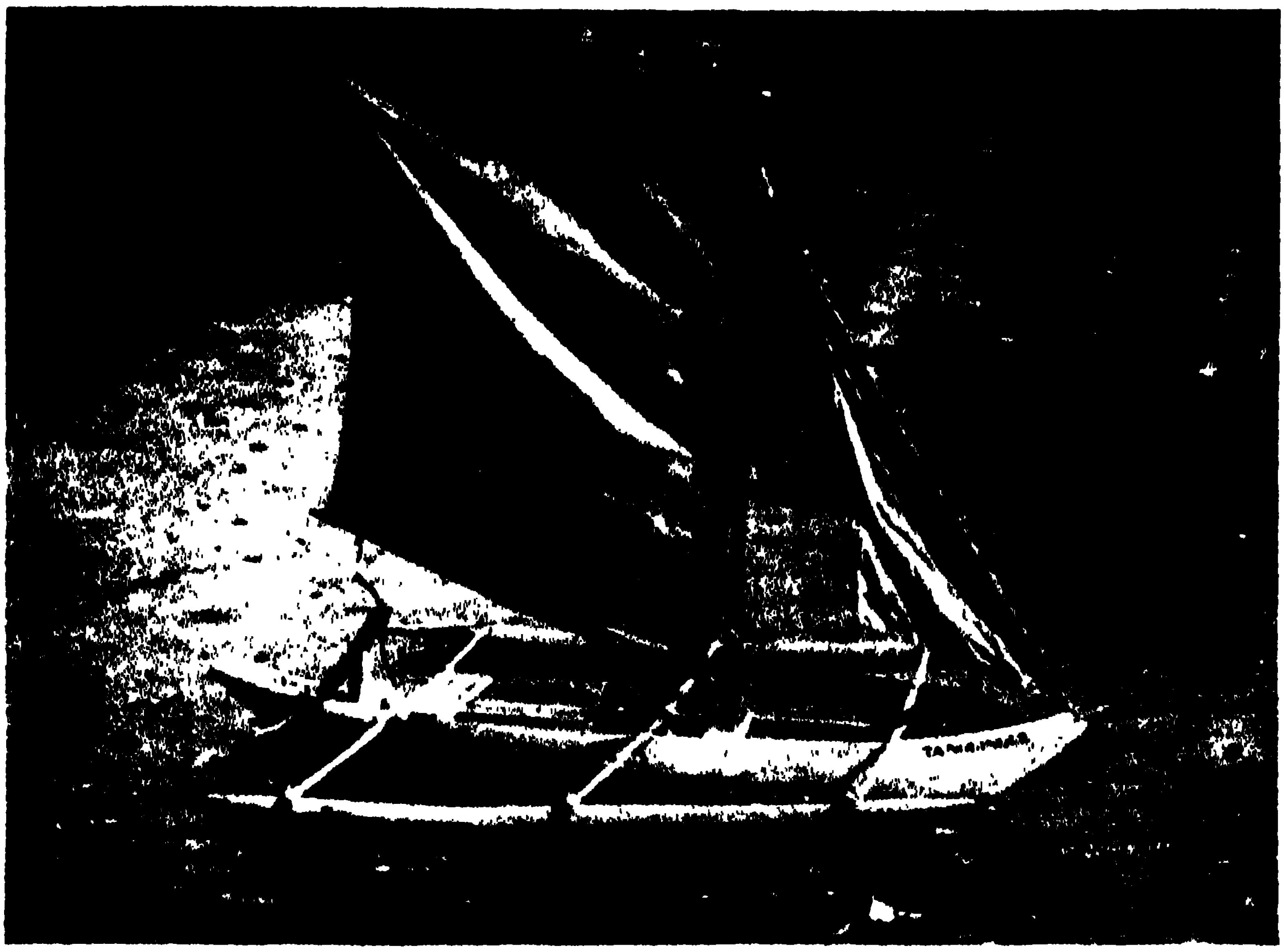

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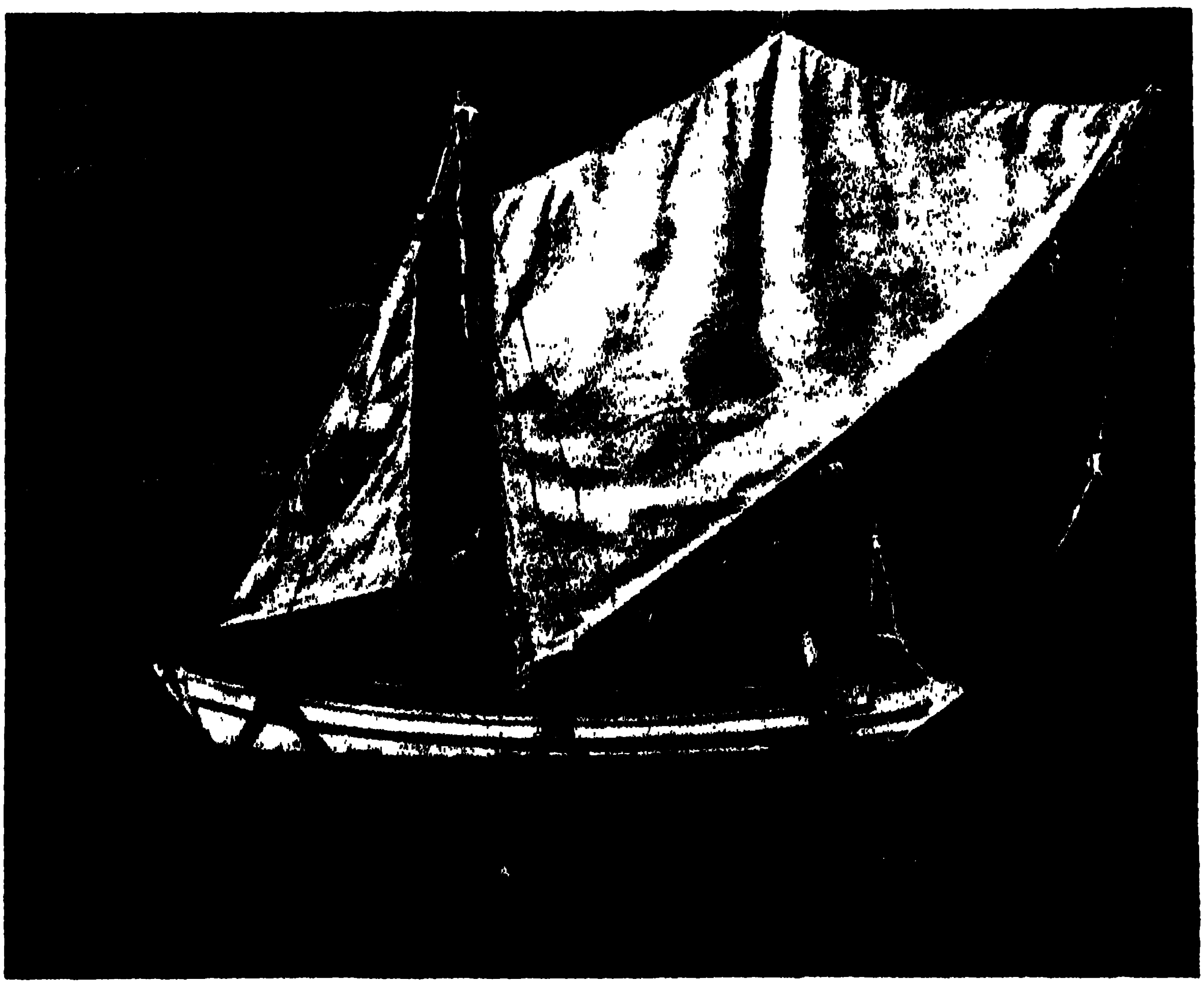

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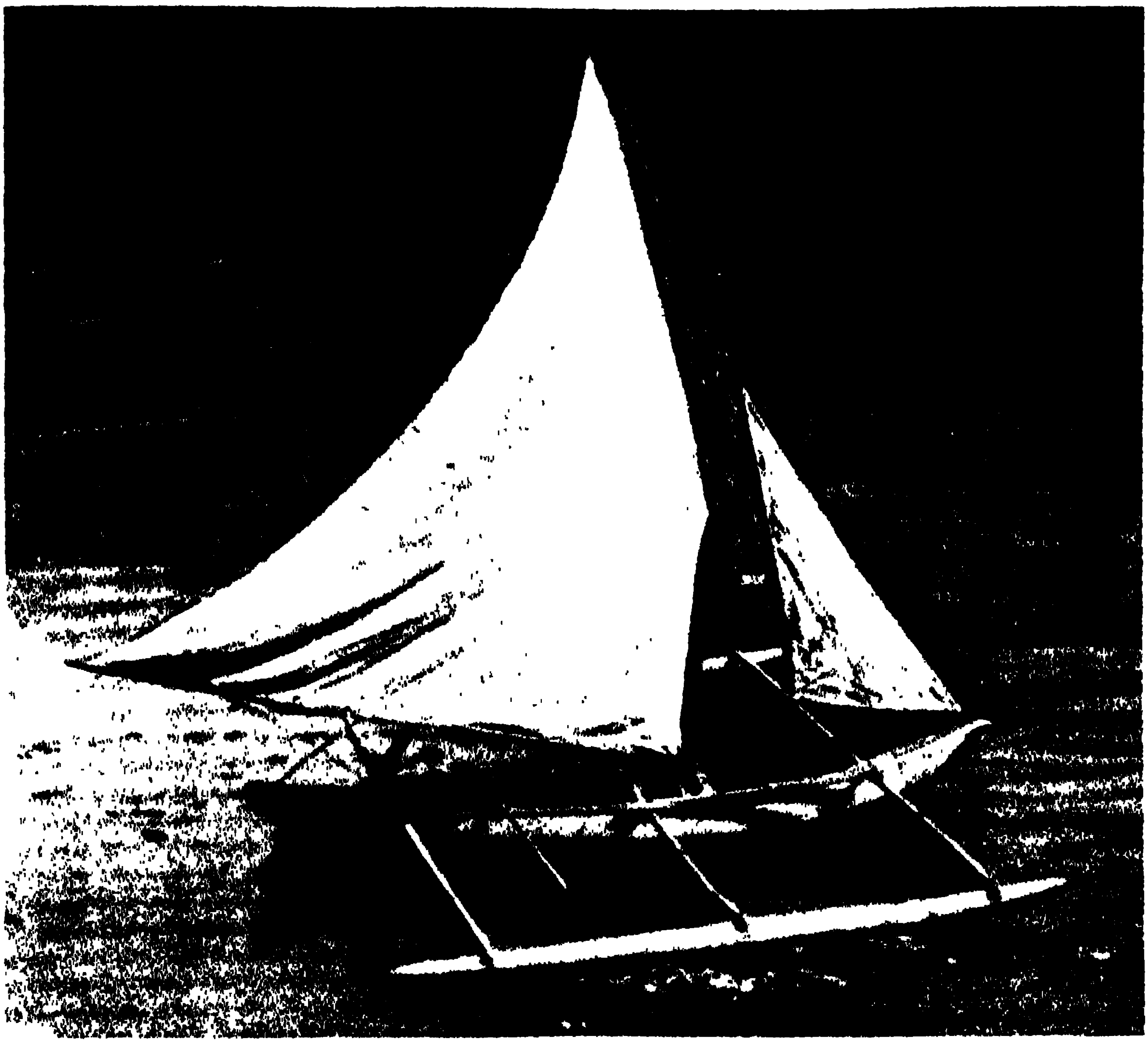

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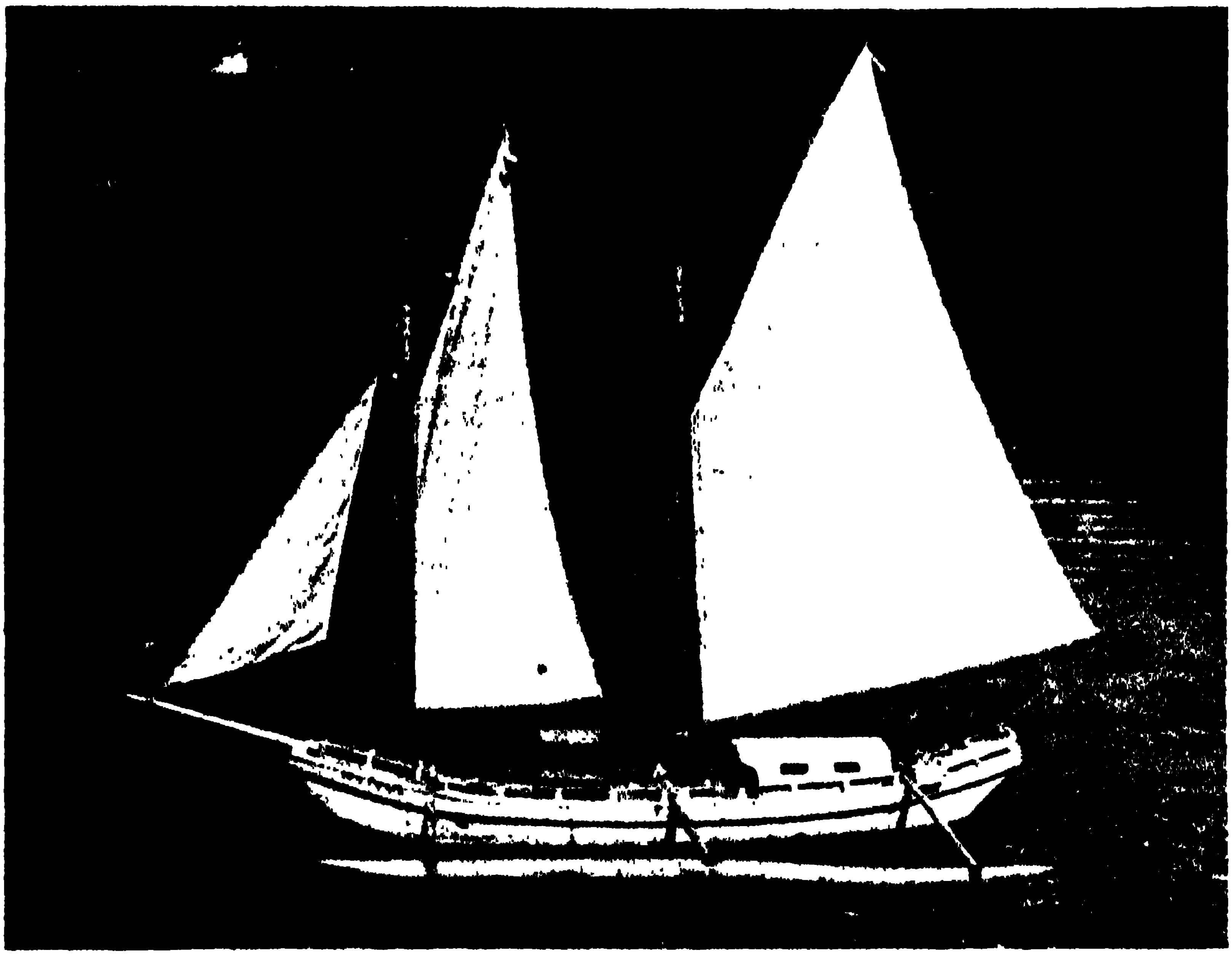

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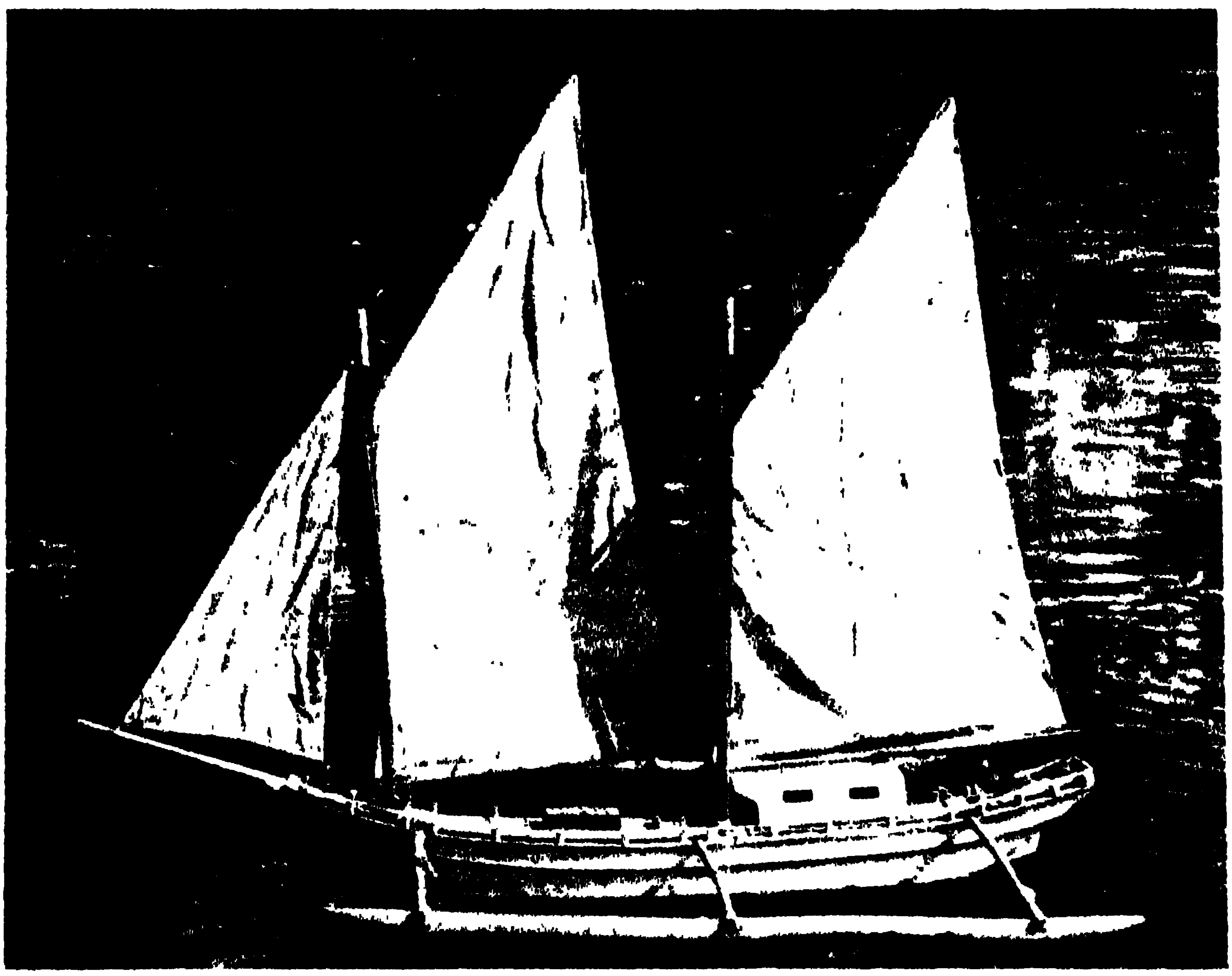

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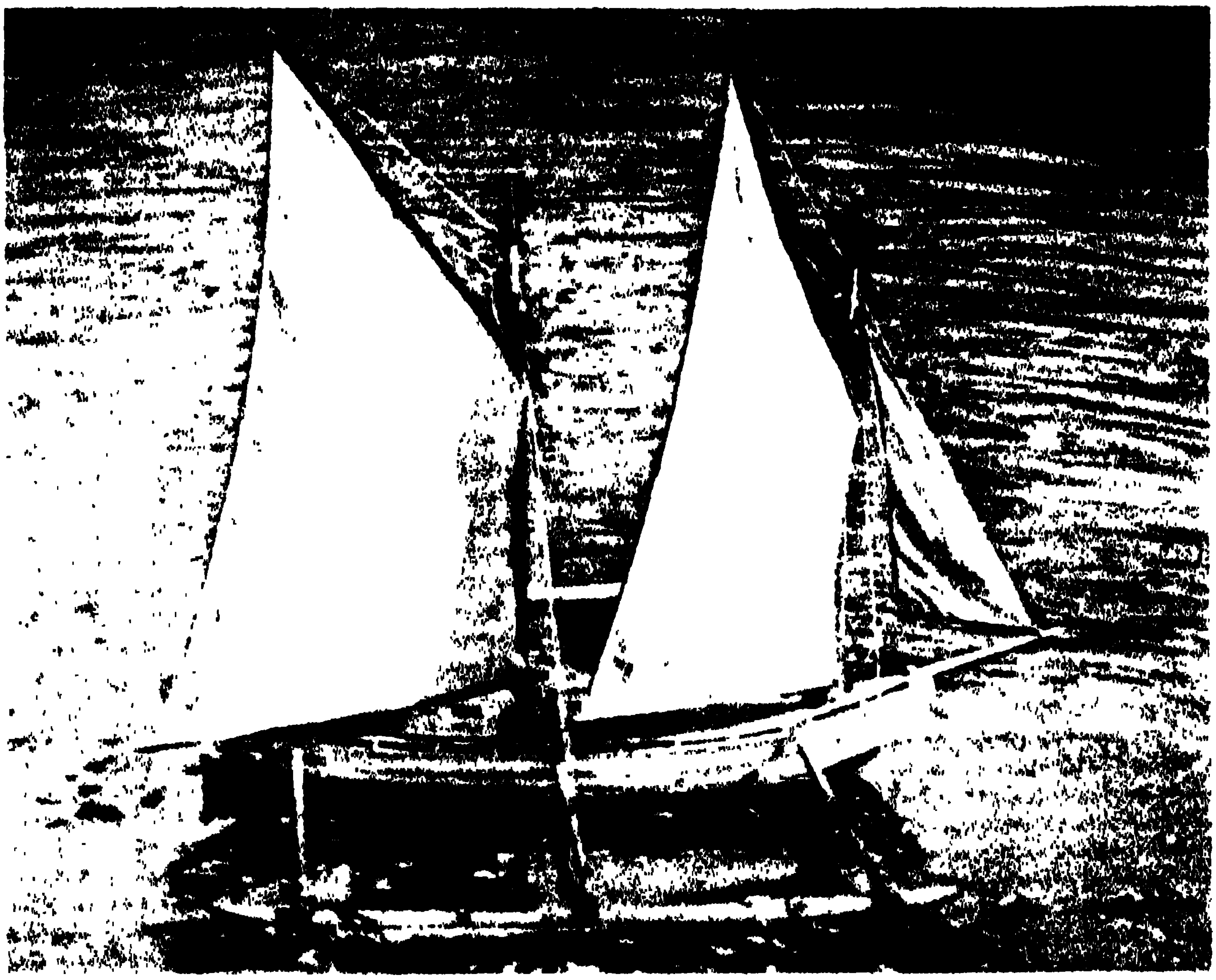

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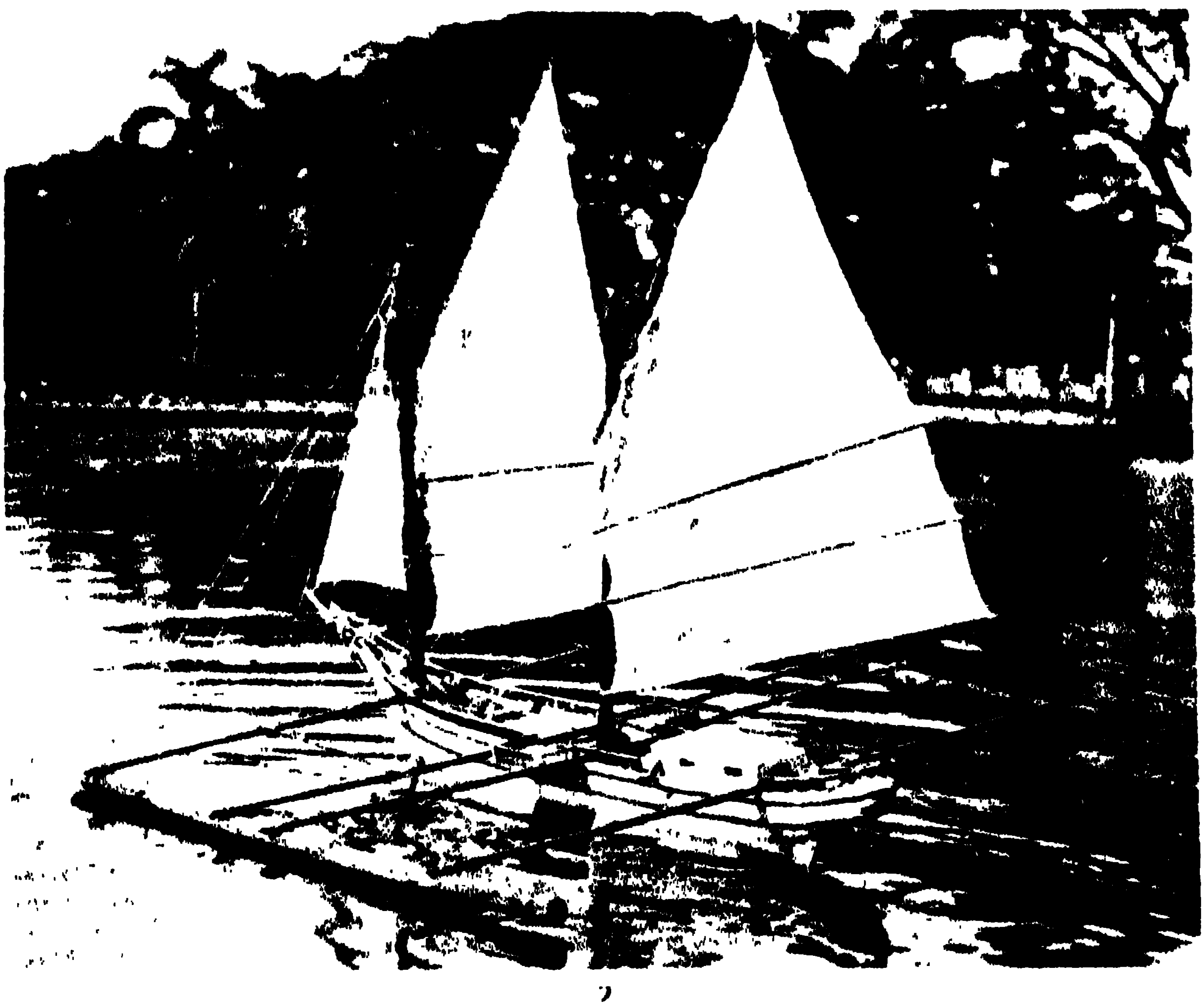

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PLATE 14.

THE PHILIPPINE JOURNAL OF SCIENCE

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THREE PHILIPPINE ANOPHELES OF THE FUNESTUS-MINIMUS SUBGROUP[1]

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TWO PLATES AND EIGHT TEXT FIGURES

The species now generally known as *Anopheles minimus* has been recorded from the Philippines under a variety of names since 1904. The occurrence on Luzon Island of a second larval form, with frayed or branched instead of simple clypeal hairs, has also been known to the local workers since about 1924.[2]

At the time of my first trip to the Philippines in 1929, adult characters corresponding to this second type had not been fully worked out, and as the two kinds of larvæ had always been found together it was still considered questionable whether they were not merely variations of one species. Specimen material for a detailed study of the two forms was collected during the first four months of that year, but comparative material from other regions was lacking and the matter of names applicable to the species could not be satisfactorily settled in the time then available.

[1] The studies were conducted with the support and under the auspices of the International Health Division of the Rockefeller Foundation, in coöperation with the Philippine Bureau of Science, the Philippine Health Service, and the United States Bureau of Entomology.

[2] From studies made by W. D. Tiedeman and F. E. Baisas. A description of the larva of *A. minimus*, with the variations found in the branching of the clypeal hairs, was published by Baisas in 1927.

In the meantime, Manalang (1930) has published a partial description of these two forms and, following Strickland (1924), has come to the conclusion that *Anopheles minimus* is identical with the African *funestus*. The second species, with branched clypeal hairs, was believed by him to be related to *Anopheles aconitus* and was described as *Anopheles aconitus* var. *filipinæ*.

In regard to the position of *A. minimus*, Evans (1930), Puri (1930), and Christophers and Puri (1931) have pointed out a number of differences between it and *A. funestus*. To these I can now add several others, in larval as well as male genitalic characters, and since these differences impress one as being more distinctive, if anything, than those separating some of the other members of the group (for example *filipinæ* and *minimus*) the specific identity of *minimus* can hardly be doubted.

With reference to var. *filipinæ*, Manalang (p. 258) states that when there are two interruptions on the basal third of the wing costa "it is surely *aconitus*" (that is, var. *filipinæ*), and in giving the variety a new name he evidently overlooked the fact that two species with this particular character have previously been described from the Philippines, namely, *Myzomyia mangyana* Banks and *Myzomyia febrifera* Banks.

The presence of such spots is indicated in the original description of *M. mangyana* (as noted by Christophers, 1924, p. 50) and their occurrence on *M. febrifera*, though not given by Banks, is indicated by Walker and Barber in an article published the same year [1914 p. 385 "front edge (of wing) black, with 5 yellow spots and a pale-yellow tip"]. The type specimens of the two species, still available in the Bureau of Science collection at Manila, show the two white spots toward the base of the costa and, as *filipinæ* was not differentiated from either of these, it was to be concluded that the name constituted another synonym.

Upon finally working up my own accumulated material, however, I find that three species, instead of two, are distinguishable in the Philippine fauna. As a consequence, the disposition of the names becomes more complicated since the third species also has a double interruption at the base of the costa.

The information available on the subject and the conclusions reached are more fully discussed in a later part of the paper but may be briefly stated here.

Myzomyia mangyana was described in 1906 from specimens collected by Mr. R. C. McGregor at Chicago, Rio Baco, Mindoro

(an island just to the southwest of Luzon), and several female specimens from this lot remain in the Bureau of Science collection. Although the specimens are mostly in poor condition, they have plainly marked costal white spots over the humeral crossvein in addition to the usual presector white spots.

Myzomyia febrifera was described by the same author in 1914 from specimens furnished by E. L. Walker and M. A. Barber from Canlubang, Laguna Province, Luzon. The author makes no reference to his previously described species, or to Ludlow's *M. flavirostris* also described in 1914.

In 1915, Miss Ludlow expressed her belief that only one form was present in the Islands, and, from the adult characters as described, all three names have since been regarded as synonyms of *A. minimus*. Banks evidently accepted this synonymy as he has made no subsequent effort to establish his species as distinct. Furthermore, his *febrifera* identifications in the Bureau of Science collection include at least two forms, so his grounds for separating the species originally are decidedly obscure.

Nevertheless, after a careful examination of all the material in the collection, I am reasonably sure that the type of *M. febrifera* and most of the other specimens from the same source do correspond to the third species as defined here. The position of *M. mangyana* is less definite since the type specimen might be either *febrifera* or *filipinæ* so far as the markings can be made out. The matter could possibly be settled more conclusively by a re-study of the type locality, which unfortunately is rather inaccessible and has not been visited. I am, however, of the opinion that it is the same as *febrifera*, judging by the environment in which it was collected (recently described to me by Mr. McGregor), by the presence of the humeral spots on each of six specimens, a percentage of occurrence that would be unusual for *filipinæ*, and by the probable absence of fringe spots at vein 6.

For the present, therefore, the name *filipinæ* is retained and the name *mangyanus* is assigned to the third species, *febrifera* becoming a synonym of the latter.

Our commonest form, corresponding more closely to typical *minimus*, differs in certain respects from specimens obtained in the type locality (Hong Kong) and is treated in the present paper as a variety, *Anopheles minimus* var. *flavirostris* Ludlow.

In connection with the findings referred to, it may be recalled that the species ("*Anopheles febrifer*"), which Walker and Bar-

ber found to be highly susceptible to laboratory infection with malaria parasites, has always been regarded as *Anopheles minimus.* The probability that most of their material was not *minimus* (or its Philippine variety) is accordingly of considerable importance. Moreover, the two forms have almost certainly been confused to a greater or lesser extent in field studies connecting *minimus* with malaria transmision under natural conditions. The occurrence of *mangyanus* on Luzon now appears to coincide with a recognized "malarious type" of country somewhat more closely than does that of var. *flavirostris* since the latter is known to be present in nonmalarious areas, and the question of another important carrier in the Philippines must therefore be taken into consideration.

ASSOCIATION OF SPECIES AND GENERAL BREEDING CONDITIONS

The three Philippine species are all typically small-stream breeders, and the collections frequently show *minimus* (var. *flavirostris*) associated with one of the other two.

Larvæ of *filipinæ* have usually been taken merely as occasional specimens in the *minimus* collections, but several places have been observed in which they were fairly numerous and where they equaled or exceeded the latter in numbers. The breeding places in one of these areas centered at a pond supplied with flowing water from several springs and full of aquatic vegetation. Larvæ of both kinds were taken in the pond and its overflow ditch, and in various small creeks, canals, and springs in the surrounding area. At another place numerous *filipinæ* larvæ in nearly "pure culture" were taken at the edge of a stream flowing from a large spring. Part of these were collected in a growth of *Pistia* and part in a growth of water morning-glory, *Ipomoea* sp. In other instances the larvæ have been taken in pure culture in a growth of water hyacinth and along the grassy margin of canals. (See also footnote 11.)

My present records of the occurrence of *A. mangyanus* are not extensive but the species is evidently quite widely distributed on Luzon and the larvæ have been taken in considerable numbers in certain localities. For the most part they have been found in swiftly flowing streams, free of aquatic vegetation, close to the mountains or in forested areas. Although usually mixed with *minimus* larvæ, *mangyanus* has been the predominating form in a majority of collections in which it occurs at all. Differences in temperature or in organic composition of the water may

account for its slightly different distribution. Like *minimus*, the most favorable collecting place is among exposed tree-roots in under-cut banks. As a mountain or forest stream breeder, however, *mangyanus* has not as yet been taken except at low altitudes.[3]

Anopheles minimus is found throughout the foot hills and rolling lands generally and, as indicated, tends to overlap each of the others. I also have a number of records in which all three species were collected in the same or nearby streams, so their breeding limits are not sharply drawn.

From the observations made it may be concluded that, while the species have preferences for somewhat different types of breeding-places, they are frequently more or less closely associated under natural conditions.

SPECIFIC STATUS

The occurrence of the three species in the same localities undoubtedly throws some light on the specific status of all the members of this subgroup, a question on which various opinions have been expressed.

The fact that they maintain distinctive characteristics although associated in nature is very convincing evidence that interbreeding does not normally occur and for this reason the three should be regarded as distinct species, rather than varieties of one. In view of this it is of interest to note that the anatomical differences are of about the same order as or even less distinctive than those separating *funestus*, *minimus* (type form), and *aconitus*, to mention only those that I have compared, so the evidence also tends very strongly to confirm the opinion held by Christophers, Edwards, and others in regard to the specific differentiation of these forms.

COMPARATIVE MATERIAL

In connection with the study of the Philippine species of this group I have fortunately been able to obtain, either from the type or other representative locality, a few specimens of several of the related species. This material consists of adults and larvæ of *Anopheles minimus* from Hong Kong and Kow-

[3] Several collections in mountain streams have shown *mangyanus* associated with *Anopheles insulaeflorum* Swell., a species not hitherto identified from the Philippines.

loon, China, *Anopheles aconitus* from Java, and *Anopheles funestus* from Sierra Leone and Nigeria, Africa.[4]

From the comparative study it has developed that fairly distinct and constant differences between several of the species are to be found in the characters of the male genitalia, particularly in the hairs of the claspettes and also, in *A. funestus*, in the size of the leaflets of the mesosome. These differences have not, I believe, been previously recorded and in fact the genitalia have been generally considered as entirely similar.

OTHER ORIENTAL SPECIES

The two Indian representatives of the subgroup, *Anopheles listoni* Liston and *Anopheles varuna* Iyengar, have not been available for comparison, but the published descriptions indicate that they are sufficiently distinct from the Philippine species.

Anopheles formosaensis I Tsuzuki (from Formosa) is considered by Yamada (1925) to be synonymous with *A. minimus* and to differ from var. *flavirostris*. *Anopheles cohæsa* Dönitz (Java) was proposed as a substitute name for Tsuzuki's *formosaensis I*, and *Anopheles merak* Mangkoewinoto (also from Java) was thought by its author to be probably identical with Dönitz' *cohæsa*. These have been included by Christophers among the synonyms of *minimus*, and the possible relation of the Javan form to one of the Philippine forms cannot be definitely determined from the published descriptions.

DESCRIPTION AND DISCUSSION OF SPECIES

The species considered here belong to the subgenus *Myzomyia* and group *Myzomyia* as defined by Christophers (1924). I have referred to the species as members of the "*funestus-minimus* subgroup." Christophers and Puri (1931) have suggested the term "*funestus* series."

[4] For their kindness in sending me this material, I am very much indebted to Dr. R. Soesilo for the *aconitus* specimens, to Dr. R. M. Gordon for those from Sierra Leone, and to Dr. M. A. Barber for the Nigerian specimens, which were obtained at Lagos, Ibadan, and Abeokuta, the latter having been sent to Doctor Barber by Doctor Anderson. The Chinese specimens were personally collected in 1929, with the kind assistance of the Medical and Sanitary Services at Hong Kong.

ANOPHELES MINIMUS var. FLAVIROSTRIS Ludlow.

Pyretophorus minimus GILES (not Theobald), 1904b.
Myzomyia funesta LUDLOW (not Giles), 1905 to 1914, in part.
Myzomyia flavirostris LUDLOW, 1914a. (See also 1914b.)
Anopheles christophersi EDWARDS (in part, not Theobald), 1914.
Anopheles (Myzomyia) christophersi LUDLOW (in part, not Theobald), 1915.
Anopheles minimus EDWARDS (not Theobald), 1915.
A. minimus var. *aconitus* CHRISTOPHERS (not Dönitz), 1916.
A. (Myzomyia) minimus CHRISTOPHERS (in part, not Theobald), 1924.
M. minima var. *flavirostris* YAMADA, 1925.
Anopheles minimus BAISAS, 1927. (Description of larva.)
Anopheles funestus MANALANG (in part, not Giles), 1930 *et seq.*

The type locality of *Myzomyia flavirostris* is Camp Wilhelm, Tayabas Province, Luzon, and the type specimens (four females) are now in the United States National Museum.

The species was described as new because of the flavescent appearance of the proboscis, but shortly after publishing the description, the author placed her species as well as Banks' *M. mangyana* and *M. febrifera* in synonymy with *Anopheles christophersi*. In an editorial footnote to the same article (quoting Edwards) *christophersi* is made a synonym of *A. minimus*.

Many of the recent Philippine records for *minimus* apply to this form, but the identifications have undoubtedly included at various times the two other species now recognized.

The accompanying description of var. *flavirostris*, except where otherwise noted, is based on larvæ and reared adults from Luzon.

I have found this form to be abundant also on Negros and Mindanao and, on the latter island, collected it at elevations of about 2,000 feet (Bukidnon and Lanao Provinces). Several dozen adults from these two islands were reared from lots in which only *flavirostris* type of larvæ were identified (not, however, from individually isolated specimens with a mount of the corresponding larval skin as in the case of the Luzon series). A certain amount of variation in the markings of female specimens from the three sources may be noted in Tables 1 and 2, especially the absence of continuous dark scaling on vein 5.1 in the Mindanao specimens.

Female.—Palpi (Plate 2, fig. 2) with two broad apical pale bands of nearly equal width and normally about twice the width of the intervening black band. Proboscis (Plate 2, fig.

8) with distinct pale scaling on the apical half in nearly all specimens and in many cases resembles very closely the appearance of the proboscis in several specimens of *aconitus* at hand. The typical marking consists of a fairly definite patch of yellowish scales ventrally and laterally beginning near the middle or the apical third and narrowing toward the tip, usually separated from the labella by darker scales. In a few specimens the pale scaling extends around the proboscis, and only 4 specimens of 113 in which the proboscis was examined (59 from Luzon, 15 from Negros, and 39 from Mindanao) fail to show more than an indefinite paling toward the tip such as may be seen in other species. The marking is therefore quite characteristic of the variety but the pale scaling may be missed if the proboscis is not properly lighted when examined.

Wings.—Basal third of wing costa (Plate 1, fig. 1) entirely dark in 23 per cent of the Luzon series, a few white scales indicating the presector[5] white spot in 27 per cent and a complete presector spot in 50 per cent, one specimen only with an additional small spot above the humeral crossvein. Another specimen from Negros, not from an identified larva, also has a small humeral spot.

Subcostal and subapical costal white spots much reduced, each averaging about one-third the length of the subapical dark area; subapical dark spot on vein 1 occasionally with a few white scales (5 to 70 specimens); veins 2.1 and 2.2 without central white spots; vein 3 on an average with more than half of the central portion white (one specimen with the vein continuously dark scaled); vein 5.1 usually with a central white area, although about one-fourth of the Luzon specimens are entirely dark scaled (except at the tip and crossvein) as in *funestus.* None of the Mindanao specimens, however, show this condition (Table 1). Vein 6 either with or without a pale spot interrupting the basal half of the dark area but without a pale interruption on the apical half such as occurs in some specimens of *filipinæ;* wing fringe dark opposite the sixth vein in all specimens except one; white fringe spots opposite all other veins and continuous between veins 2.2 and 3.

Male.—A few pale scales above the humeral crossvein and a slight fringe spot at the end of vein 6 are occasionally noted

[5] The terminology of the wing spots as employed here has been given in a previous article (King, 1932, fig. 1).

in male specimens, while the proboscis is not usually pale scaled as in the female. The antennal club has a narrow basal white band, a wide white area centrally and a white tip.

TABLE 1.—*Variations in female wing spots in several species of Anopheles of the funestus-minimus series.*

	Anopheles minimus var. *flavirostris*.			*Anopheles minimus*.	*Anopheles funestus*.		*Anopheles mangyanus*.	*Anopheles filipinae*.
	Luzon.	Negros.	Mindanao.	Hong Kong.	Sierra Leone.	Nigeria.		
Number of specimens examined	70	15	40	4	6	14	46	38
White spots on basal third of costa	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
No spots	23	33	20	0	0	54	0	0
One [a]	76	60	80	100	100	46	0	45
Two [b]	1	[c] 7	0	0	0	0	100	55
Accessory sector and sector spots on vein 1:								
Continuous	36	20	48	75	100	79	9	36
Separated [d]	64	80	52	25	0	21	91	64
Central white spot on vein 5.1.								
Present	73	87	100	50	0	0	86	84
Absent	27	13	0	50	100	100	14	16
Dark spots on vein 6:								
One	29	53	5	0	50	7	9	8
Two	71	47	95	100	50	93	91	65
Three	0	0	0	0	0	0	0	27
Fringe spot at vein 6:								
Present	1	0	0	0	0	0	5	73
Absent	99	100	100	100	100	100	95	27

PROPORTION OF CENTRAL WHITE AREAS ON VEINS 3 AND 5.1 TO TOTAL LENGTH OF VEIN (MEASURED TO CROSSVEIN).

Vein 3, average	[e] 0.54	0.63	0.69	0.60	0.27	0.35	0.66	0.63
Vein 5.1, average [f]	0.29	0.30	0.42	0.44	0.0	0.0	0.32	0.28

[a] The presector white spot. This spot was incomplete or represented by only one or two scales in about half (55 per cent) of the *flavirostris* specimens listed as having one spot.

[b] Humeral and presector white spots.

[c] One specimen.

[d] Includes those with only one or two dark scales intervening.

[e] Does not include one specimen with vein 3 continuously dark scaled.

[f] Does not include specimens in which the central white spot is lacking.

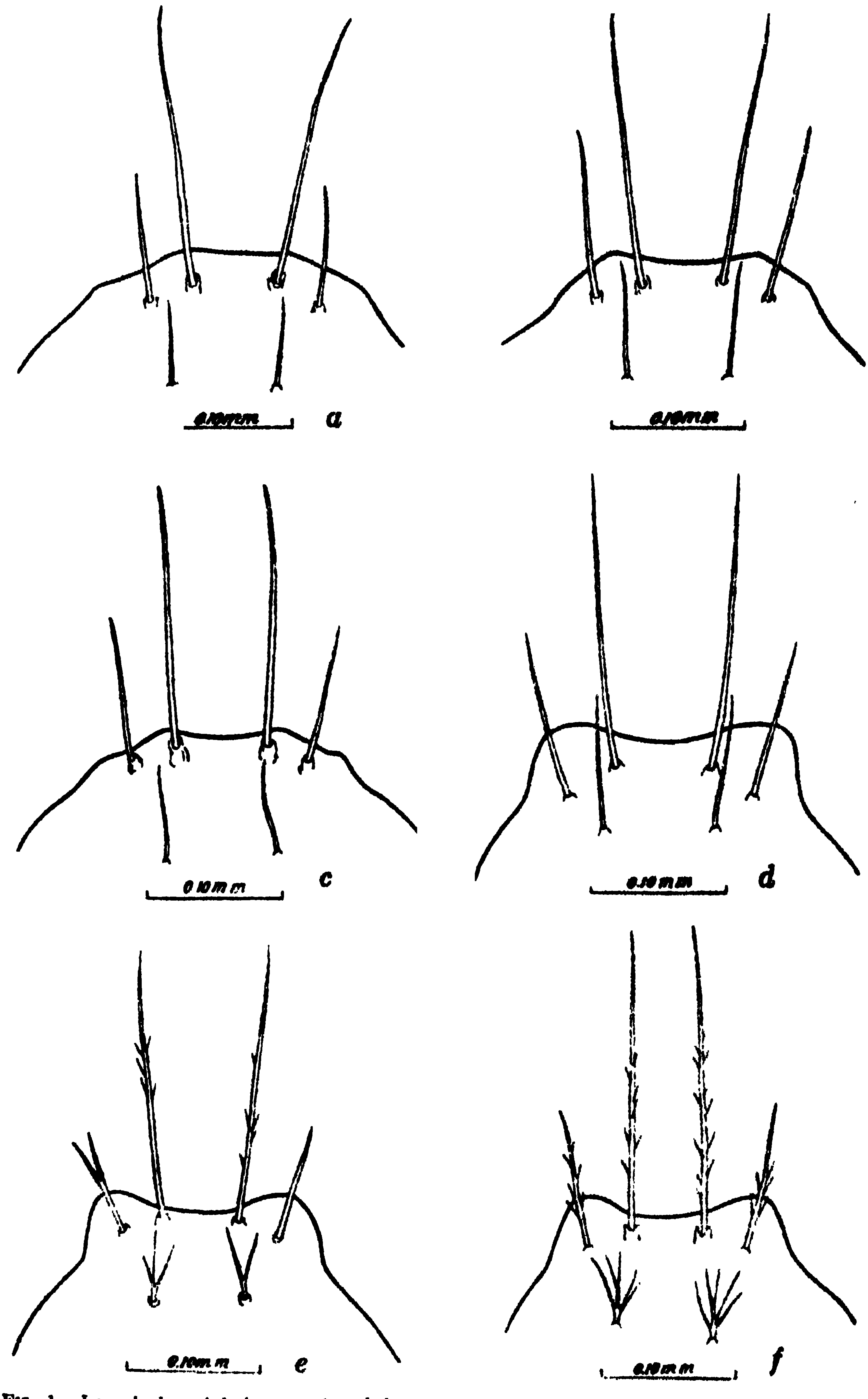

FIG. 1. Larval clypeal hairs; *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles mangyanus*; *c*, *Anopheles minimus* (type form); *d*, *Anopheles funestus*; *e*, *Anopheles filipinae*; *f*, *Anopheles aconitus*.

Male hypopygium.—Mesosome (fig. 8, *a*) with four or five pairs of leaflets, the first one wide and flat and serrated on one side nearly to the tip; other leaflets shorter and narrower and one or two of them also serrated. Average length of the longest leaflet, 36 μ.

TABLE 2.—*Comparative widths of the distal palpal bands of the female in several species of Anopheles.*

	Number measured.	Apical white band (average proportion).	Subapical dark band (average proportion).	Subapical white band (average proportion).	Variation in proportion of subapical white.
Anopheles minimus var. *flavirostris*:					
Luzon	18	0.40	0.19	0.41	0.33–0.48
Negros	12	0.40	0.20	0.40	0.33–0.47
Mindanao	22	0.38	0.24	0.38	0.33–0.43
Anopheles minimus: Hong Kong	5	0.40	0.24	0.37	0.28–0.48
Anopheles funestus:					
Sierra Leone	5	0.32	0.42	0.26	0.23–0.30
Nigeria	16	0.29	0.47	0.24	0.17–0.34
Anopheles mangyanus	*40	0.41	0.23	0.36	0.26–0.44
Anopheles filipinae	34	0.48	0.25	0.27	0.18–0.37

* Two specimens in which the subapical dark band is lacking are not included.

Claspette (harpago) (fig. 7, *a*) with three long hairs, consisting of an inner and outer hair of nearly equal length, and a longer and stouter apical hair. The outer hair is about the same length as the club or slightly shorter, but arises farther forward on the lobe and extends beyond the tip of the club. The inner hair was present on both sides in all specimens except two and in each of these cases the hairs on one side had plainly been broken off during dissection since the small basal cone could be made out (in addition to the circular "root spot," bearing a minute hair, that is found in all specimens). Duplication of any one of the claspette hairs may occur and the club may also be double or have a separate leaflet.

The parabasal spines and the shape of the leaflets of the mesosome are quite similar in all the species of the subgroup that have been examined. Certain differences, to be noted under each form, occur in the hairs of the claspettes and in the length of the mesosomal leaflets (Table 3).

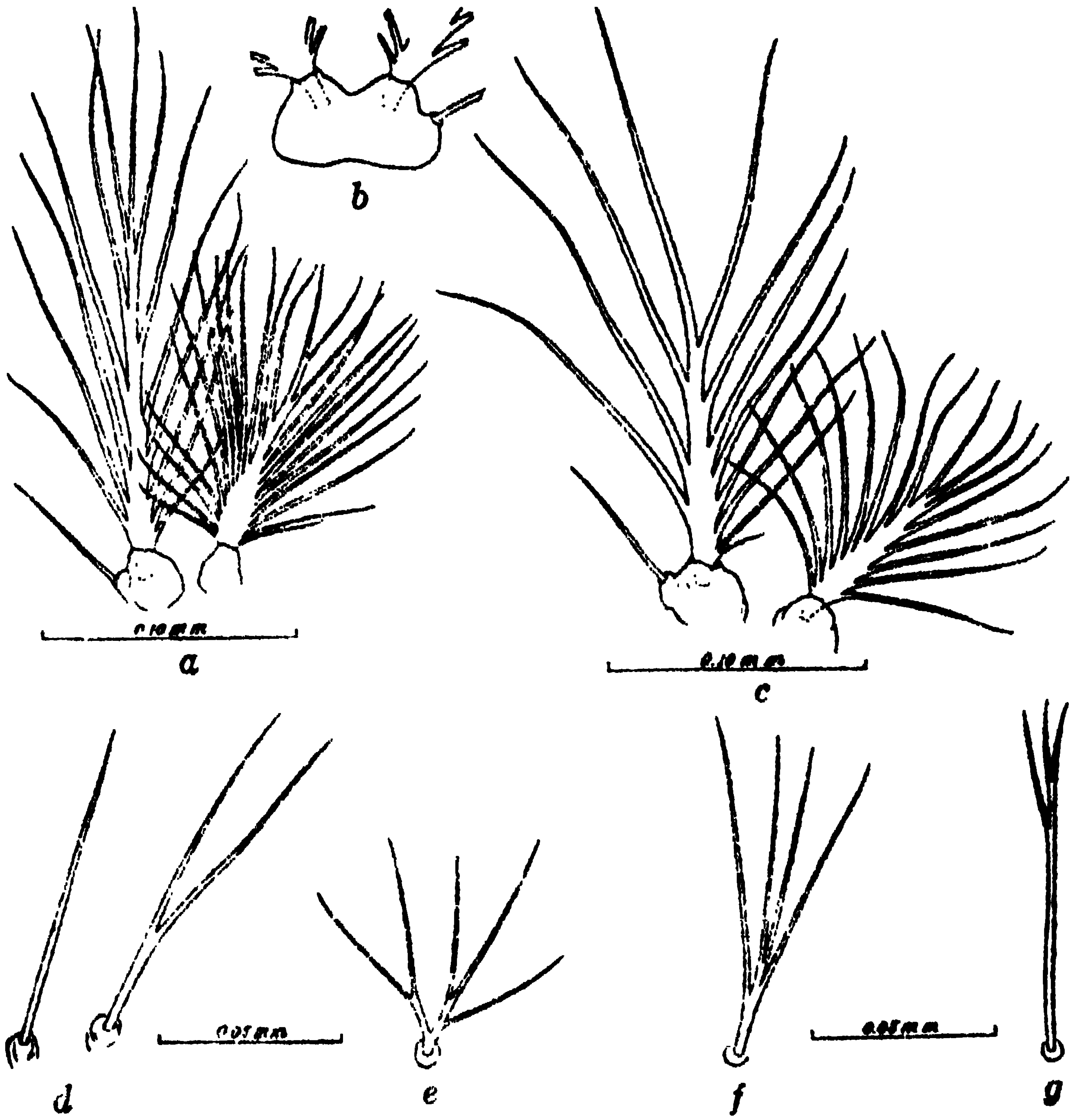

FIG. 2. *a*, submedian prothoracic hairs of *Anopheles minimus* var. *flavirostris*; *b*, bases of the submedian prothoracic hairs of *Anopheles funestus*, showing the type of fusion in this species; *c*, submedian prothoracic hairs of *Anopheles filipinæ*; *d*, inner (left) and outer occipital hairs of *Anopheles funestus*; *e*, inner occipital hair of *Anopheles minimus* var. *flavirostris*; *f*, antepalmate hair from abdominal segment II of *Anopheles minimus* var. *flavirostris*; *g*, the same of *Anopheles filipinæ*.

Larva.—Inner clypeal hairs (fig. 1, *a*) long and simple; outer hairs stout and about half the length of the inner; posterior hairs slender and seldom reach beyond the base of the inner; outer and posterior clypeal hairs occasionally forked toward the tip. Inner occipital hairs (fig. 2, *c*) usually with more than three branches and in typical specimens the hair is divided near the base with secondary branches arising from each stem. Inner submedian prothoracic hairs (fig. 2, *a*) with a stout stem and numerous, symmetrically arranged branches, averaging 24 branches each and seldom with less than 21; bases of the submedian hairs usually separated, but are narrowly fused on one

TABLE 3.—*Measurements of the mesosome, the mesosomal leaflets, and the claspette spines of the male hypopygium in several species of Anopheles.*

	Anopheles minimus var. *flavirostris*.	*Anopheles minimus* (Hong Kong).	*Anopheles funestus* (Africa).	*Anopheles mangyanus*.	*Anopheles filipinæ*.	"*Anopheles febrifer*." [a]
Number of specimens	16	5	6	17	10	6
Mesosome:						
Number measured	12	4	4	15	6	4
Average length[b] μ	83	91	106	90	86	98
Variation μ	80-94	87-94	103-108	82-99	75-94	92-106
Long leaflets of mesosome:						
Number measured	27	10	12	33	18	10
Average length μ	36	36	49	36	30	39
Variation μ	34-38	34-38	45-53	31-41	28-33	34-42
Inner claspette hair:						
Number measured	25	4	2	4	0	0
Average length μ	52	36	29	42	...	...
Variation μ	38-68					
Apical claspette hair:						
Number measured	25	10	12	33	18	12
Average length μ	78	79	69	75	72	83
Variation μ	68-85	71-85	61-78	63-85	70-88	75-87
Outer claspette hair:						
Number measured	31	12	12	35	18	12
Average length μ	51	52	30	50	47	54
Variation μ	42-56	56	26-38	35-56	40-56	49-59
Club of claspette						
Number	32	10	12	34	1	12
Average length μ	58	61	65	54	57	59
Variation μ	49-71	56-63	58-71	42-61	47-66	51-66

[a] M. A. Barber's specimens having humeral costal spots and without an inner hair on the claspette. Specimens from Canlubang, Laguna Province, 1914.

[b] The measurements were made at a magnification of × 425, and are given in microns.

or both sides in about 25 per cent of the specimens and occasionally broadly fused, as in *funestus;* thoracic palmate hairs (fig. 3, *a*) not extended into a slender filament; leaflets of abdominal segments with comparatively short filaments, ratio of filament to blade (Table 5), 0.54; antepalmate hairs (hair 2) on abdominal segments 2, 3, and 7 branched near the base (fig. 2, *f*), usually from three to five times, those on segment 3 being somewhat more variable than the others in regard to the point of branching, but the first branches arise from the basal third.

Tergal plates.—The plate on segment 1 (fig. 4, *a*) is narrow and more or less rectangular in shape except for a projection in front; the main plate on segment 2 is invariably notched or concave posteriorly (as noted by Manalang) and the small me-

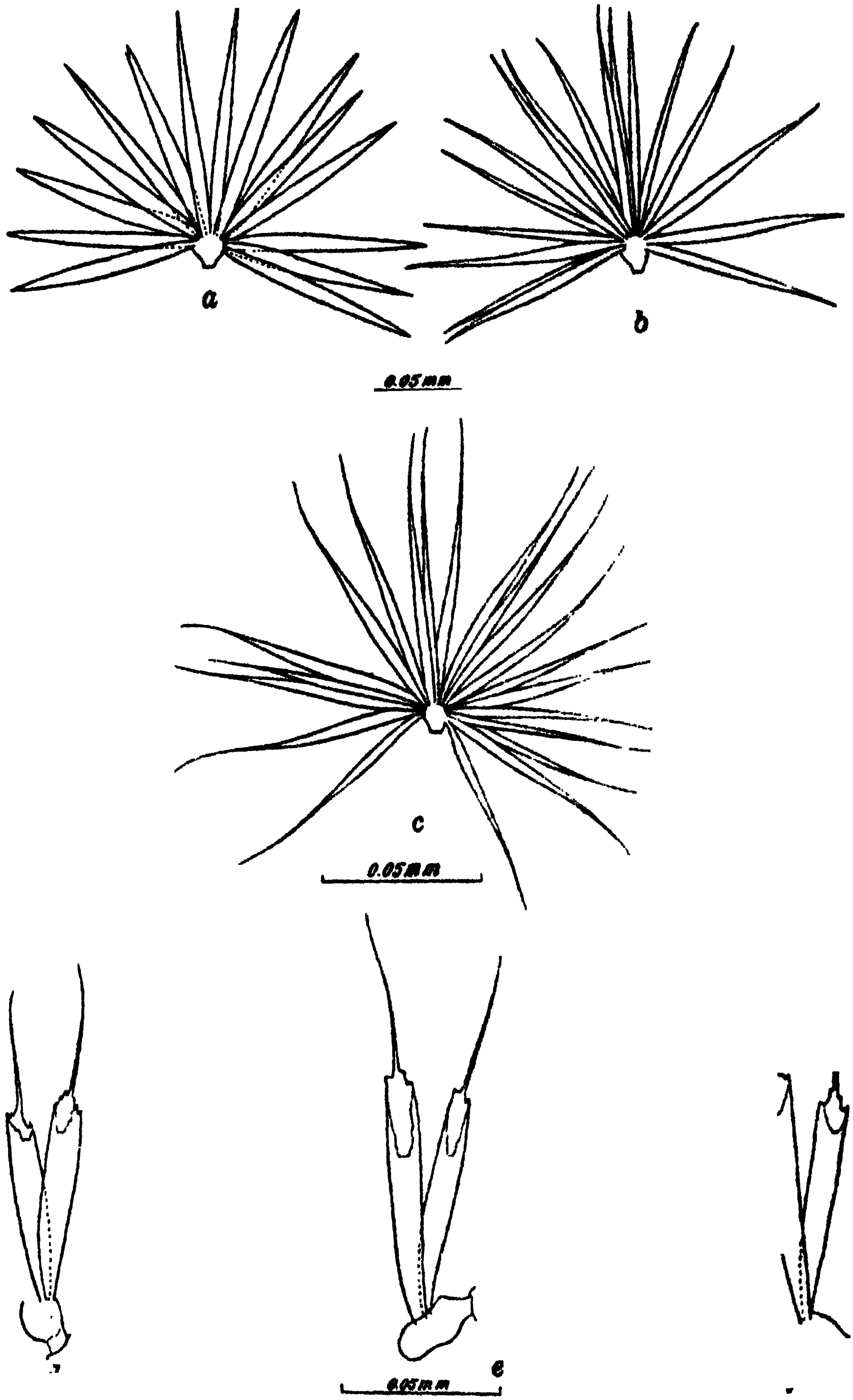

FIG. 8. Thoracic palmate hairs (*a* to *c*) and leaflets of abdominal palmates from segment IV (*d* to *f*); *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles filipinæ*; *c*, *Anopheles mangyanus*; *d*, *Anopheles minimus* var. *flavirostris*; *e*, *Anopheles mangyanus*; *f*, *Anopheles filipinæ*.

dian plate or a detached portion of the main plate lies in this concavity. The first two plates are similar to those of *mangyanus*. The remainder of the plates, except on segment 8, have a decidedly convex posterior margin as a rule and taper to more or less of a point at each end. This is especially noticeable on segments 3, 4, and 5, and in typical specimens the shape is decidedly different from that of *filipinæ*, *mangyanus*, or *funestus*. In some specimens the plates on segments 3 to 6 are almost diamond-shaped and some have the small median plate detached on segment 3 or 4. The small oval submedian or posterior plates are not well chitinized as a rule, but in cleared specimens they are frequently visible, especially toward the posterior end, or they may be indicated by an unchitinized scar. The minute anterior tergal hairs, hair "O" of Puri, usually do not arise from the main plate but their location is subject to some variation. In the majority of specimens they are well separated (at least their own length away); in others they may arise from the very edge of or sometimes definitely on the plate itself. These hairs are usually simple.

The dorsal surface of the larva is mottled with a dense subdermal pigmentation that extends well forward under the tergal plates on the abdominal segments. Small spots of opaque white are scattered through the dark pigmentation, especially on the thorax. On the ventral side of the abdominal segments are small central pigmented spots. The general naked-eye appearance of the larva is very dark brown or black and differs in this respect from most of the *filipinæ* larvæ.

In living or freshly killed larvæ and especially in those preserved in formalin the pigmentation is frequently so dense that the tergal plates are obscured and the posterior margin difficult to make out. For study purposes it is helpful to clear the specimens in caustic soda before mounting.

In the cast larval skins or in cleared larval specimens, minute scattered spines (the vestitural setæ) are barely visible on the ventral surface of the abdominal segments, but never produce prominent dark bands as observed in *funestus* larvæ.

ANOPHELES MINIMUS Theobald, 1901.

Female.—Definite pale scaling of the proboscis is not apparent in the ten female specimens at hand from Hong Kong and was not noted by Yamada (1925) in those he examined. The frequency and extent of the pale scaling in the Philippine form is therefore of some significance.

TABLE 4.—*Comparative branching of larval hairs in several species of Anopheles.*

	Anopheles minimus var. *flavirostris* (Luzon).		*Anopheles minimus* (Hong Kong).		*Anopheles funestus* (Africa).		*Anopheles mangyanus* (Luzon).		*Anopheles filipinae* (Luzon).		*Anopheles aconitus* (Java).	
	Number	Per cent.	Number	Per cent.	Number	Per cent.	Number.	Per cent.	Number	Per cent.	Number	Per cent.
Larval spec ecorded	111		8		21		79		102		5	
Inner clype rs:												
Simple	202	100	14	100	40	100	155	99.4	1	0.5	0	
Frayed	0		0		0		0		189	99.4	10	100
Outer clypeal irs												
Simple	202	99	16	100	42	100	154	100	155	79	0	
Two to 4 an d	2	1	0		0		0		40	21	0	
Frayed	0				0		0		0		10	100
Postclypeal h irs:												
Simple	205	99	16	100	26	100	157	97	15	7	0	
Two to 4 bran ed	3	1	0		0		4	3	192	93	10	100
Inner occipital hair												
Variation in number of branches	2-12		4-8		1		2-9		2-8		4-7	
Average	5.2		5.6		1		5.0		3.3		5.0	
Usual	3-7	94			1	100	4-6	71	2-4	92	4-5	75
Outer occipital h												
Variation	2-12		4-9		2-4		3-10		2-8		5-9	
Average	4.8		5.9		2.3		6.3		3.8		6.1	
Usual	3-6	95			2-3	97	5-7	76	2-5	93	5-6	67
Submedian protl hairs:												
Inner—												
Varia	18-30		21-31		16-23		13-26		12-22		10-21	
Avera	24.2		25.8		19.1		20.9		16.8		16.9	
Usual	22 plus	89	21 plus	100	17-21	94	18-23	91	14-20	97		

Middle—												
Variation	11-20		14-20		12-17		12-20		10-18		10-13	
Average	14.1		16.9		14.6		15.2		13.2		11.6	
Antepalmate hairs:												
Segment II—												
Variation	3-7		4-6		3-6		2-5		2-6		3-5	
Average	4.6		4.8		4.7		3.5		3.3		4.1	
Usual	4-5	86			5	35	3-4	90	3-4	81		
Segment III—												
Variation	2-6		2-4		3-5		1-4		1-4		2-3	
Usual	3-4	93	3-4	88	4-3	90	2-2	95	3-2	89	3	51
Segments IV to VI—												
Variation	1-2		1		1-2		1		1-2		1	
Usual	1	99.5	1	100	1	99	1	100	1	99.8	1	100
Segment VII—												
Variation	3-5		3-5		2-5		1-2		2-5		3-4	
Usual	3-4	92	3	63	4	56	1	93	4-2	82		
Lateral hairs:												
Segments IV to VI—												
Variation	2-4		2-7		2-5		2-4		2-5		3	
Usual	3	91	3	97	2	85	3	65	3	95	3	100

[a] Both hairs in each pair were counted so far as possible, except that in the case of *flavirostris* and *filipinae* only one of the inner and the middle submedian prothoracic hairs was recorded.

[b] One inner clypeal hair forked at tip.

[c] Hairs forked.

TABLE 5.—*Measurements of palmate leaflets in three Philippine species of Anopheles.*

	Number measured.[a]	Blade.	Filament.	Total length.	Ratio of filament to blade.
		mm.	*mm.*	*mm.*	
Anopheles minimus var. *flavirostris*	78	0.064	0.034	0.098	0.54
Anopheles mangyanus	126	0.065	0.057	0.122	0.88
Anopheles filipinæ	121	0.062	0.039	0.101	0.63

[a] Two leaflets measured per specimen, one each from segments IV and V.

Christophers and Puri (1931) state that some of the Indian *minimus* have a small pale tache on the ventral side of the pro-

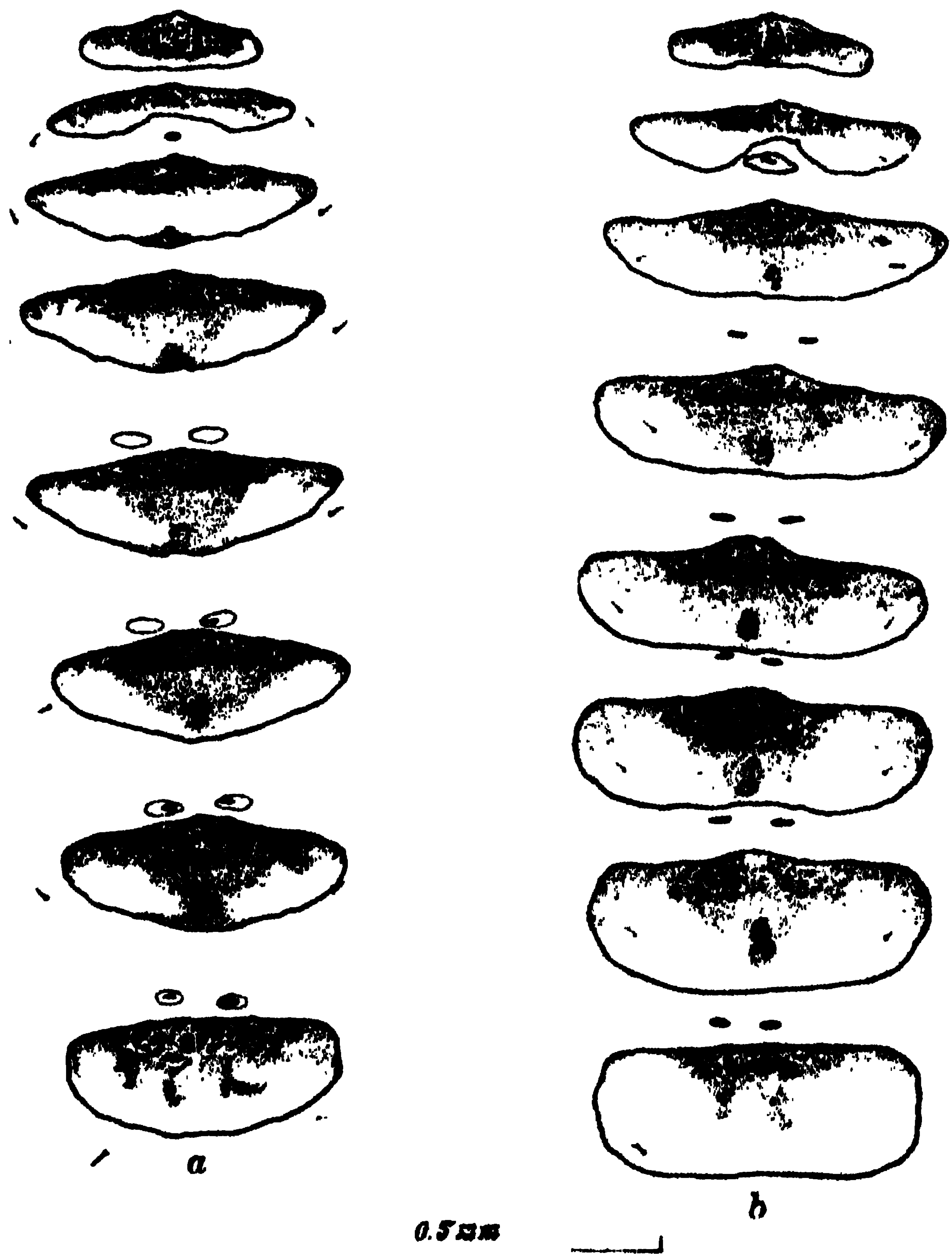

FIG. 4. Tergal plates; *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles mangyanus*.

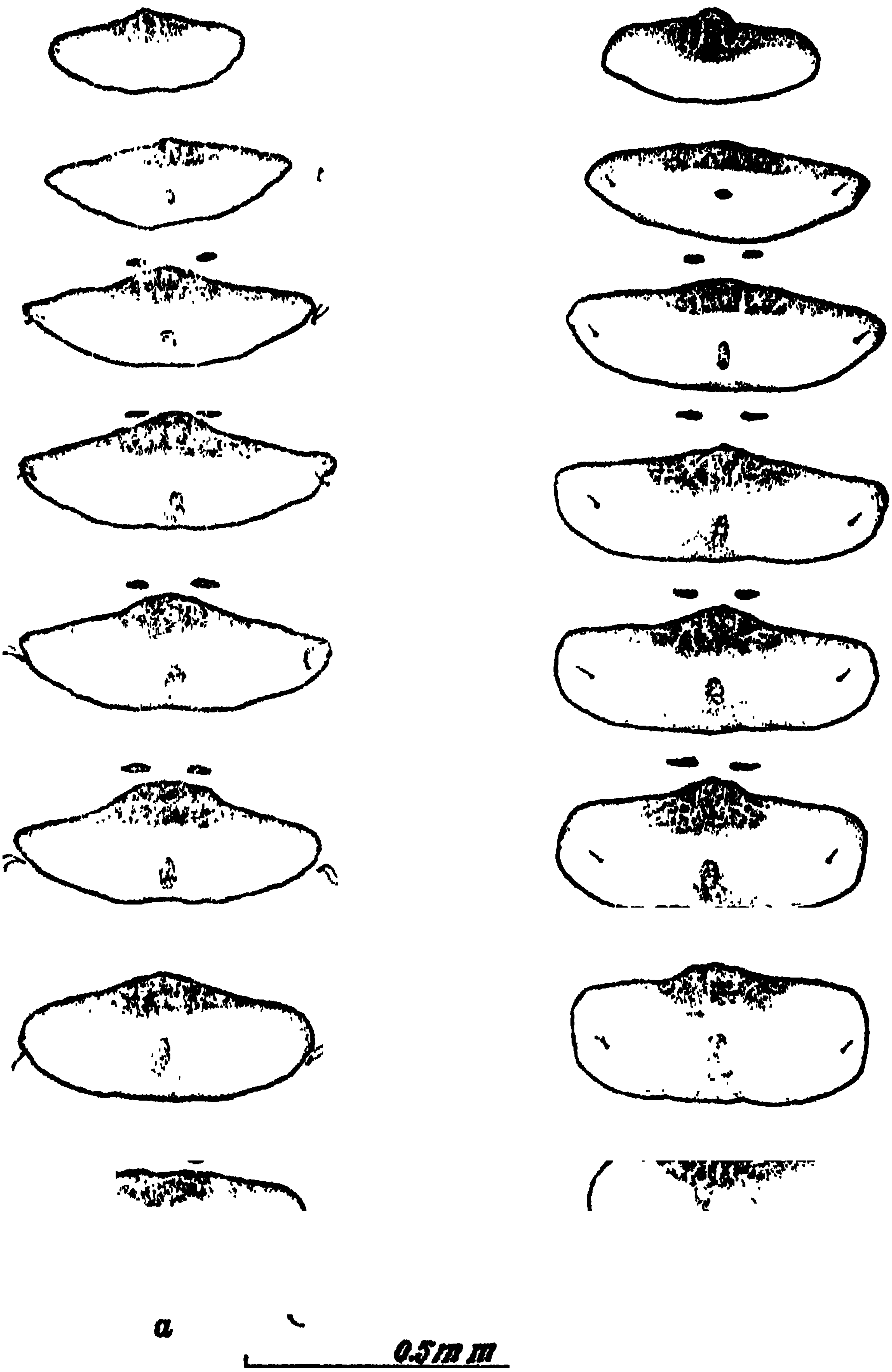

FIG. 5. Tergal plates: *a*, *Anopheles aconitus*; *b*, *Anopheles filipinæ*.

boscis but the marking is apparently much less constant and distinct in that form than in var. *flavirostris*.

These authors also state that a white interruption at the base of the wing costa occurs very constantly in their series and this may be compared with the entirely dark-scaled base in 23 per cent of the Luzon specimens.

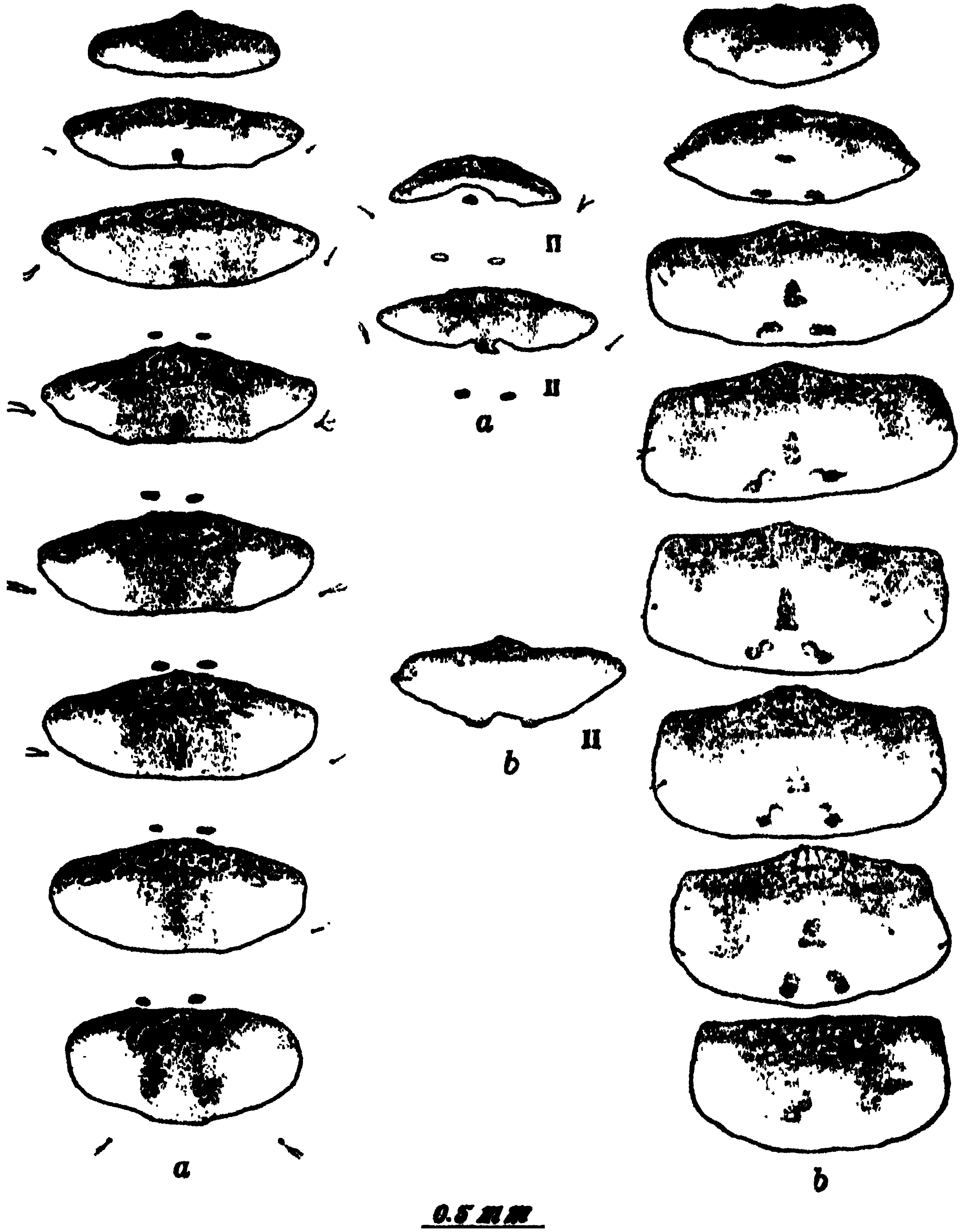

FIG. 6. Tergal plates and examples of variations in the shape of plate II; *a*, *Anopheles minimus* (type form); *b*, *Anopheles funestus*.

Male hypopygium.—The development of inner claspette hairs shows a decided tendency to differ in the two forms. In var. *flavirostris*, as previously stated, a long inner hair is present in each of seventeen specimens while of five Hong Kong males the hair is absent in two (fig. 7, *b*), a short hair is present on one side in one (fig. 7, *c*), a fairly long hair on one side in another, and short hairs are present on both sides in the fifth.

None of the five, therefore, is exactly similar to the normal condition of the claspette of the Philippine specimens.

Larva.—So far as observed, the larval characters are quite similar to those of var. *flavirostris* with the exception of the shape of the second tergal plate, the branching of the anterior tergal hairs, and possibly in the increased amount of chitinization of the small submedian plates, including those on the metathorax.

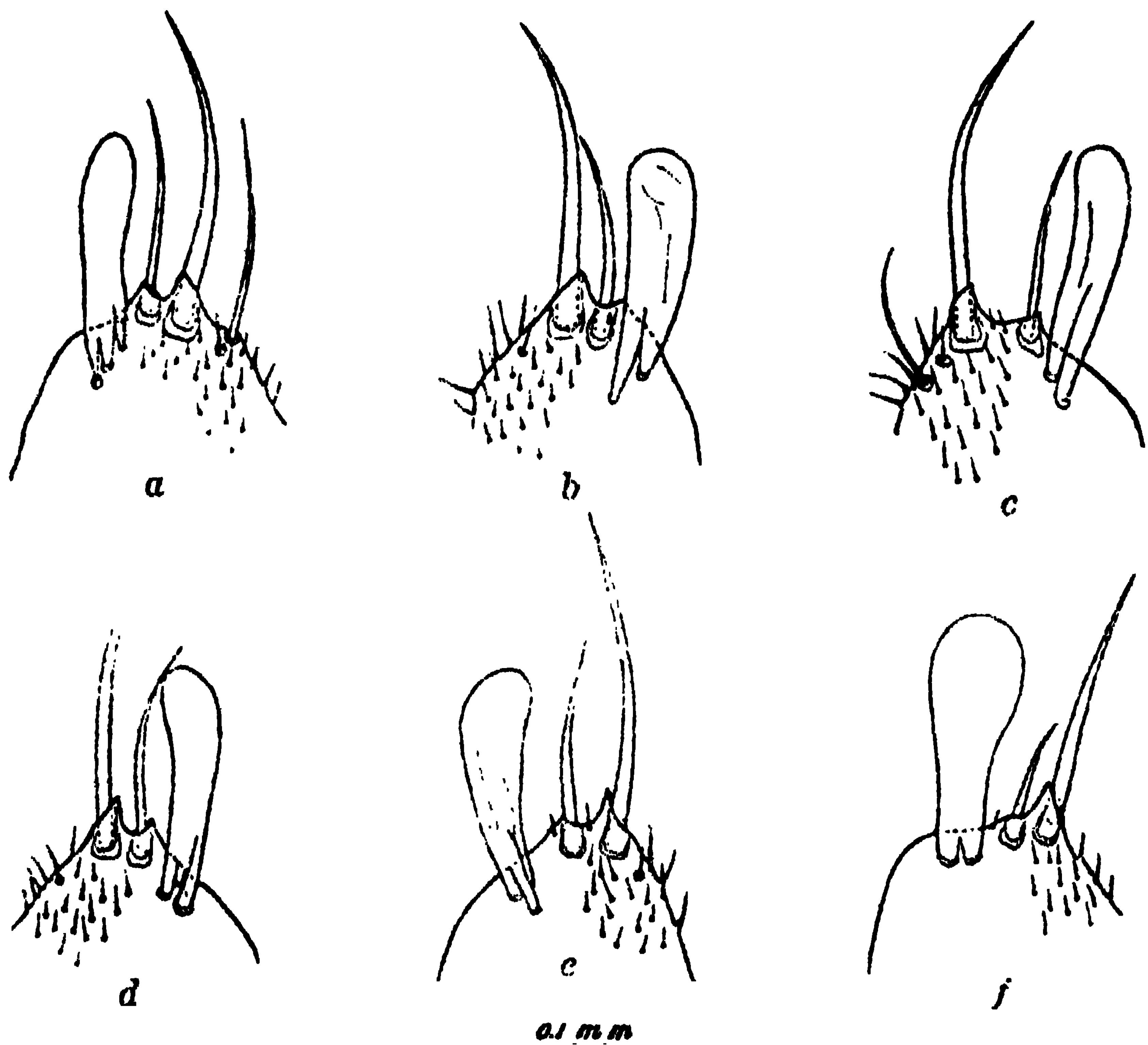

FIG. 7. Claspette hairs of male hypopygium; *a*, *Anopheles minimus* var. *flavirostris*; *b* and *c*, *Anopheles minimus* (type form), the second figure showing a short inner hair; *d*, *Anopheles mangyanus*; *e*, *Anopheles filipinæ*; *f*, *Anopheles funestus*.

The second tergal plates are variable in shape (see fig. 6, *a*), two specimens having the anterior plate crescent-shaped and the median plate detached as in *flavirostris*, two with the anterior plate only slightly notched but the median plate also detached, and three with the median plate fused with the main plate. In two of the last three the posterior border is straight and unbroken, a condition that has not been observed in any specimens of the Philippine form.

The anterior tergal hairs do not ordinarily arise from the plate in either form but they are usually bifid in the Hong Kong specimens, instead of simple, and are sometimes 3- or 4-branched.

While the two forms are plainly more closely related than are other members of the group, the differences are sufficient to justify the rank of geographical subspecies.

ANOPHELES FUNESTUS Giles, 1900.

The specimens examined from Sierra Leone and Nigeria show the characteristics as given by various authors and these may be briefly summarized as follows:

Female.—Palpi (Plate 2, fig. 4) with a broad subapical black band, as wide as or wider than either white band; basal third of wing costa with or without one white interruption; vein 3 about two-thirds dark; vein 5.1 dark except for small white spots at the tip and crossvein; fringe dark opposite vein 6. (The wing is illustrated in Plate 2, fig. 1).

Larva.—Clypeal hairs (text fig. 1, *d*) all simple; inner occipital hair simple (instead of branched as in all other members of the group) and outer occipital usually only 2- or 3-branched (fig. 2, *d*); small submedian tergal plates fused with the main plates (instead of being separated); anterior tergal hairs (hair O) arising from the large plate.

To these characters I can add that the posterior clypeal hairs are placed farther forward than usual and overlap the base of the inner anterior pair by one-half to two-thirds their own length. The inner anterior thoracic hairs tend to be slightly less branched than those of *minimus* and var. *flavirostris* and the bases of the inner and middle hairs are broadly fused (fig. 2, *b*). The tergal plates (fig. 6, *b*) are comparatively very large and differ in shape from those of the two forms mentioned.

A striking larval difference is the spinose condition of the ventral surface of the abdominal segments. This consists of numerous rows (15 to 20) of short dark spines which produce well marked bands on the central segments. The rows are transverse and the banding is especially evident in cast skins or cleared larvæ, but the setæ can also be made out readily enough in normally dense specimens.

Male hypopygium.—Outer claspette hair (see fig. 7, *f*), short and stout instead of long and slender; club unusually large and nearly as long as the apical hair; inner hair lacking in

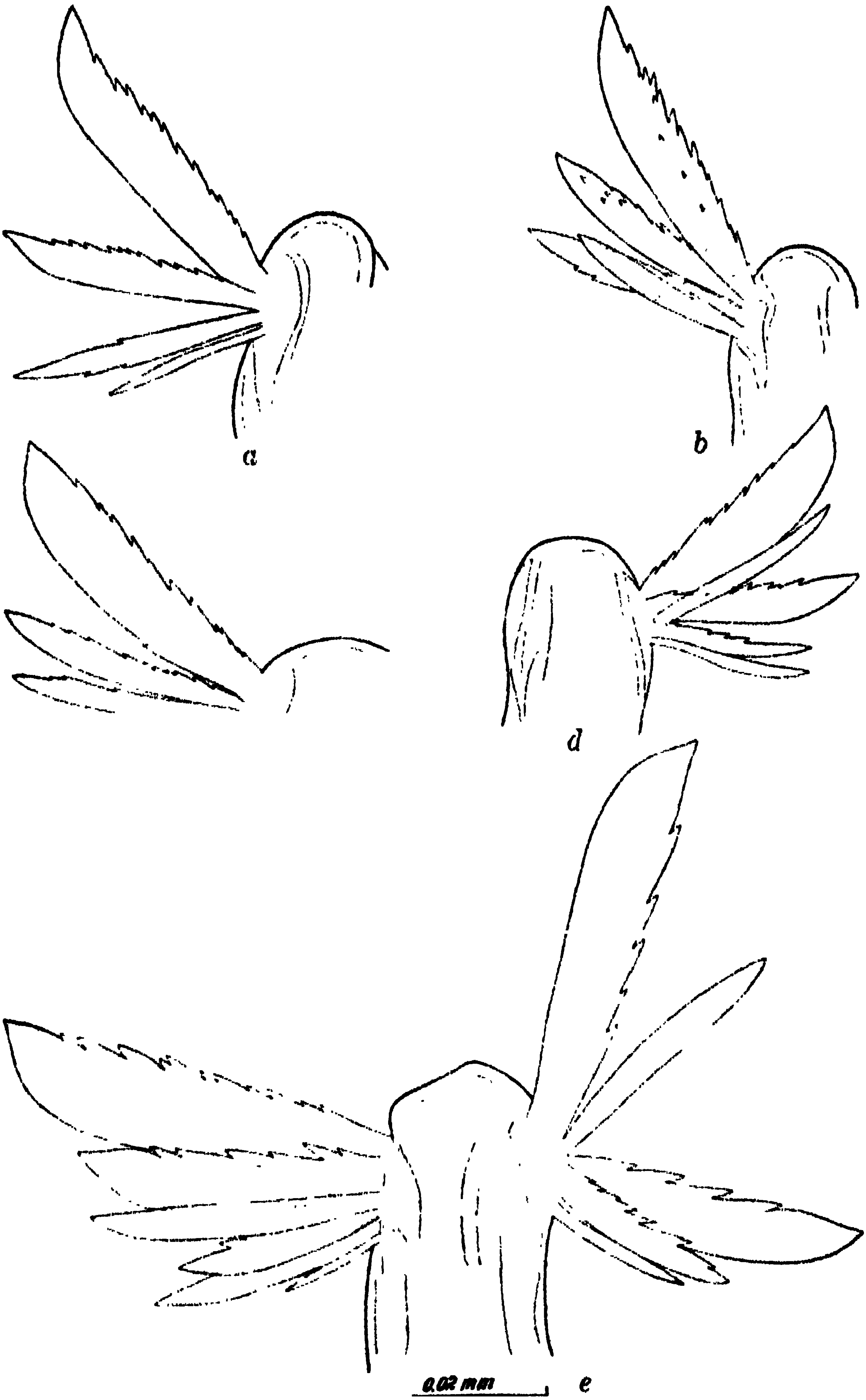

FIG. 8. Mesosomal leaflets; *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles minimus* (type form); *c*, *Anopheles mangyanus*; *d*, *Anopheles filipinæ*; *e*, *Anopheles funestus*.

five specimens but short hairs on both sides are present on the sixth.

The leaflets of the mesosome (fig. 8, *e*), and also the mesosome itself, are decidedly longer than in the other members of the group, the differences being noticeable even under the low powers of the dissecting microscope. The average length of the longest leaflet is 49 μ, compared with averages of 30 to 39 μ for any of the other species examined.

The larval and genitalic characters of *funestus* are therefore distinctive in several respects.

ANOPHELES MANGYANUS Banks.

? *Pyretophorus pitchfordi*[a] GILES, 1904*b* (not Giles, 1904*a*).
Myzomyia mangyana BANKS, 1907.
Anopheles christophersi EDWARDS (in part, not Theobald), 1914.
Myzomyia febrifera BANKS, 1914.
Anopheles febrifer WALKER and BARBER (for the most part), 1914.
Anopheles (*Myzomyia*) *christophersi* LUDLOW (in part, not Theobald), 1915.
Anopheles minimus CHRISTOPHERS (in part, not Theobald), 1916.
Probably *Anopheles minimus* and *Anopheles funestus* (in part) and possibly *Anopheles aconitus* var. *filipinæ* (in part) of Philippine authors.

The specimens of *M. mangyana* in the Bureau of Science collection (all females) consist of the type and two cotypes (so labeled), another specimen and a half dozen empty pins all bearing the same accession number (3290), and three specimens, evidently from the empty pins, which were found unmounted in the same box.

One of the unmounted specimens is in very poor condition but the other six, while in poor condition also, all have distinct humeral and presector white spots. Two of the specimens (both cotypes) still retain their palpi and in one of these the three apical bands are of about equal width; the other has both white bands wider than the dark. The subcostal and subapical costal white spots in all six specimens are from one-half to three-fourths the length of the subapical dark spot (resembling many

[a] Identified from specimens received from Camp Stotsenburg, Pamp., (Luzon) P. I. and probably of this form or *filipinæ*. *Pyretophorus minimus* was also recorded from the same collection so the identification could not be referred to var. *flavirostris*.

of my *mangyanus* specimens). Fringe spots cannot be made out at the end of vein 6, but the fringe is either faded or rubbed in all of the material. Banks' description indicates that they were not present originally. The apical half of vein 6 is without a white interruption in three specimens (undetermined in the others).

Mr. McGregor, who collected the specimens, told me that they were taken at a camp on Rio Baco about six kilometers inland from the north coast of Mindoro. Except for a small area that was being cleared for cultivation at the camp, all of the surrounding territory was heavily wooded.

The evidence as to the identity of this species is suggestive though not final and if it should prove to be the same as *filipinæ*, the form to which the name is here assigned would become *Anopheles febriferus.*

As previously mentioned, the important development in connection with the latter name is the probability that much, perhaps most, of the material for which experimental results were reported by Walker and Barber in 1914 as *Anopheles febrifer* was not *A. minimus* as has always been supposed.

The available evidence applying to the relationship of *M. febrifera* and to the identification of the Walker and Barber material may be cited as follows:

The type female of *M. febrifera* has a distinct white spot on the wing costa above the humeral crossvein; the subapical white palpal bands are only slightly wider than the subapical dark band and the proboscis is not pale; the presence or absence of a fringe spot at the end of vein 6 is doubtful since the fringe scales are quite faded. This specimen might or might not, therefore, be *filipinæ* but is almost certainly not *flavirostris.*

The Bureau of Science collection still contains about two dozen specimens labeled with various cage numbers and initialed by Doctor Barber, showing that they were from experimental lots. There are also a few from Canlubang, Capatagan, and Cristobal Rivers, small streams near the sugar central of Canlubang where the experimental work was conducted, and still other specimens, from Barber's collections, from various localities in the same province (Laguna).

Although these specimens are now practically all in poor condition, the scaling at the base of the wing can still be made out

on most of them and the distribution of the material in regard to the basal spots is as follows:

Those having a humeral white spot consist of—

Type female and male[7] labeled "Cage 56 *M. funesta* 4-2-14 M.A.B., E.L.W." and a second label "Acc. No. 18015 Bu. Sci. P. I."

One male and one female with the same cage and date label but without the accession number.

One male and nineteen females from other cage numbers, with 1914 dates and initialed "M.A.B."

Two males and seven females from Canlubang River, one male and two females from Capatagan River, and one male from Cristobal River.

Six males and ten females from other localities (Calamba, Magdalena, Los Baños, Pansol River, Antipolo, Lilio, Siniloan, San Pablo, and Santa Rosa).

Of the above, two of the males (one from the same cage as the type and one from another cage) have very small humeral spots such as occur in some male specimens of *flavirostris* and upon dissection one of these proved to have a *flavirostris* type of claspette (with inner hairs, although not quite typical). The abdomen of the other one is missing. Six other males from the series having well-marked humeral spots proved to have hypopygia similar to my *mangyanus* series (without an inner harpagonal hair and with the mesosomal leaflets more than 33 μ long). These included one male from Canlubang River, one from Capatagan River, and one from Cristobal River, all near Canlubang.

Of several female specimens in which the wing fringe is still intact none have a fringe spot at vein 6.[8] Most of the palpi have two broad distal white bands but the subapical one is narrowed in two or three specimens.

Those without a humeral white spot consist of:

One male and three females from Canlubang and Capatagan Rivers. (None from cages.)

Three males and fourteen females from other localities in Laguna Province.

Two of these males, including one from Canlubang River, had, as expected, the *flavirostris* type of harpagonal hairs and a number of the females show the characteristically pale proboscis.

[7] The author states in the original description of the male that the basal third of the wing costa is dark. The labeled specimen, however, has a double interruption.

[8] Walker and Barber also refer to the dark wing fringe at vein 6.

In summarizing the examinations it is found that only four (10 per cent) of forty-one Canlubang specimens were probably var. *flavirostris*, with two other specimens (males) doubtful. None of the twenty-one females from cages could be classified as that species. The much larger proportion of *flavirostris* among the specimens from other localities probably has no bearing on the type of material used in the experimental work.

During 1929, two collections, one in January and one in February, were made by Mr. J. J. Mieldazis and myself at Canlubang. While only part of the specimens from these lots were saved, the mounted material and descriptive notes show that four of them are referrable to the species now defined as *mangyanus*, three to *filipinæ*, and twenty-eight to var. *flavirostris*.

Further collections in October, 1931, show a still smaller proportion of *mangyanus*, only one being identified out of 280 *flavirostris* larvæ examined.

The present preponderance of *flavirostris* larvæ may, I think, be attributed to changed breeding conditions. On the occasion of my last visit I talked with a Filipino who has been employed as a nurse at the Canlubang hospital for many years and was so employed in 1913 and 1914. He accompanied me to one of the nearby streams (Canlubang Creek, or "River"), where Doctor Barber had made collections, and stated that the condition of the stream was considerably changed as regards the amount of tree growth along the banks. An indication of the change is the fact that *maculatus* larvæ are now abundant and any number could be obtained, whereas Walker and Barber state that this species was comparatively rare in 1914.[9]

The 1929 collections demonstrated the presence of all three species at Canlubang, and while there is still a possibility that the type of *M. febrifer* is the same as *filipinæ*, it seems quite remote when the entire series is considered. So large a proportion of specimens with humeral white spots would be exceptional

[9] Another interesting point brought out in connection with the apparent change in breeding conditions is that the malaria rate among the laborers was said to be fairly high in 1913 and 1914 but almost negligible now, although *flavirostris* larvæ are still plentiful. The manager of the sugar company, Mr. L. Weinzheimer, also stated that in his experience the worst malarial outbreaks have occurred during the clearing and developing of new lands and several instances were cited by him in support of this, a further suggestion of a correlation with the habits of *mangyanus*.

for *filipinæ* and most of the palpal markings do not indicate that form. Fringe spots at vein 6 are lacking and their absence is also specifically noted by Walker and Barber. Furthermore, the length of the mesosomal leaflets (Table 3) corresponds more closely to my series of *mangyanus* than to *filipinæ*.

The occurrence of the three closely related forms on one island is of unusual interest, though it does add considerably to the difficulties of identification. On my part, its presence was first suspected while studying certain specimens that had been identified either as *minimus* or "*minimus* variety" (=*filipinæ*) but which were not typical for either one. The first examples were thought to be merely extreme variations, although as the series became larger other larval differences were discovered and these were found to be correlated with a different combination of adult characters. An "intermediate" type of larva that is very likely the same form has also, I understand, been independently observed by Mr. D. Santiago among collections made by him in the vicinity of Calauan, Laguna Province.

Several hundred larvæ of this species have now been critically examined and more than a hundred reared adults are available in my collection. While the identification of the larva is a comparatively simple matter, more difficulty may be expected with some of the less typically marked adults for which the larval molt is not available.

Female.—Proboscis dark scaled. Palpal bands (Plate 2, fig. 5) variable; similar to those of var. *flavirostris* in many specimens, but the subapical white band is slightly shorter on the average and is sometimes reduced to about the width of the subapical dark band; the two white bands occasionally continuous.

Wings (Plate 1, fig. 3) with presector and humeral costal white spots in all specimens and almost always well marked; subapical and subcostal white spots usually from one-half to three-fourths the length of the subapical costal dark spot; vein 3 with the central two-thirds white; vein 4.1 with a few white scales or a definite patch on a third (36 per cent) of the specimens but white spots on veins 2.1 and 2.2, and on the subapical dark spot of vein 1 not noted; vein 5.1 usually with a white spot in the center; vein 6 usually with two dark areas, occasionally only one; fringe opposite vein 6 dark in all except two specimens.

Male hypopygium.—Mesosomal leaflets (fig. 8, *c*) usually five in number, similar in length to those of *minimus* and variety *flavirostris* but longer than those of *filipinæ;* average length of longest leaflet, 36 μ.

Inner hairs of claspette (fig. 7, *c*) usually lacking, being present in only two of seventeen specimens. In one of these the hairs are short and in the other they are about the length of the shortest ones in *flavirostris.* In both cases they are associated with duplication of some of the other hairs (a double apical hair on one side in each specimen, one outer hair double and one club double).

Larva.—Inner anterior clypeal hairs (fig. 1, *b*) long and simple; outer more than half as long, usually simple but occasionally forked; posterior hairs longer than those of *flavirostris,* usually extending perceptibly beyond the base of the anterior pair; inner occipital hairs similar to *flavirostris*, the outer with a slightly greater average number of branches; branching of submedian prothoracic hairs intermediate between *flavirostris* and *filipinæ*, usually from 18 to 23; bases of these hairs seldom fused; thoracic palmate hairs (fig. 3, *c*) end in a long slender filament, quite distinct from the shape of the leaflets in *flavirostris;* filament of abdominal leaflets also longer, ratio to blade 0.88 compared with 0.54 (Table 5); antepalmate hairs of abdominal segments 2 and 3 intermediate between *flavirostris* and *filipinæ,* tending to branch toward the center. The character is variable, however, and the hair on segment 2 may be branched from near the base while that on segment 3 may be branched near the tip, or sometimes simple; antepalmate hairs on segments 4 to 6 simple; that on segment 7 *also simple*, occasionally forked distally.

Anterior tergal plates (fig. 4, *b*) on segments 1 and 2 similar to those of *flavirostris*, the plate on segment 1 being oblong and that on segment 2 crescent-shaped with the posterior edge deeply indented (several specimens with the small median plate incompletely separated and one with this plate completely fused with the main plate); tergal plates on the other segments more nearly similar to *filipinæ* except that the ends are not quite so square. The central portion of the posterior edge of the plate is more or less straight, instead of convex as in *flavirostris*, and the ends are usually more broadly rounded; anterior tergal hairs usually arise from the plate, often deeply placed but sometimes

near the edge either on or off the plate; small submedian plates usually well chitinized as in *filipinæ*.

The larvæ are heavily pigmented dorsally like *flavirostris*, except that the opaque white spots are more abundant and, on the thorax, are collected into two rather definite, submedian white streaks or lines. Ventrally, the abdominal segments have inverted T-shaped patches of pigment.

Although some of the larval characters resemble those of *flavirostris*, some *filipinæ* and others are intermediate, the combination is quite distinctive. The simple clypeal hairs and the shape of the first two tergal plates distinguish it from *filipinæ* while the shape of the thoracic palmate hairs and the simple antepalmate hair on segment 7 separate the species from *flavirostris*. For confirmation of identification, the length of the posterior clypeal hairs, the number of branches in the submedian thoracic hairs, the position of branching of the antepalmate hairs on segments 2 and 3, the shape of the tergal plates (after the second), the position of the tergal hairs and the pigmentation are useful.

My collection records show its occurrence in the following localities: Nayon, Ifugao (1929), Calauan, Laguna, (1929), Canlubang, Laguna (1929 and 1931), Los Baños, Laguna, (1931), near Atimonan, Tayabas (1931), Abucay, Bataan (1931), Bongabong, Nueva Ecija (1932), all on Luzon, and Gumbala-on and Fabrica, Negros Island (1931). I have also examined specimens received from Drs. P. F. Russell and R. L. Holt from Masbate Island and from the provinces of Camarines Sur, Sorsogon, and Albay, Luzon.

The collection at Fabrica, Occidental Negros, was made in a mountain stream, on the banks of which were the remains of a logging camp, abandoned, according to the statement of Mr. M. E. Grey, manager of the Insular Lumber Company, because of a severe and persistent outbreak of malaria among the laborers.

Collections of *mangyanus* at Bongabong, Los Baños and on the eastern side of Bataan Province were also associated with locally reported malarious areas. Taken in conjunction with the records from Canlubang its connection with malaria transmission is very definitely suggested. It has not as yet, however, been identified from malarial foci on Mindanao, Jolo or Tawi Tawi.

ANOPHELES FILIPINÆ Manalang.

Anopheles minimus varieties 1, 2, and 3, BAISAS, 1927.
Also "*minimus* variety" of Philippine authors.
Anopheles aconitus var. *filipinæ* MANALANG, 1930.
Anopheles filipinæ CHRISTOPHERS and PURI, 1931.

This species was separated from *minimus* on the basis of the branched clypeal hairs and because of this character was considered to be closely related to *aconitus*. Except for this resemblance, however, there appears to be little reason for considering their relationship any closer than that of some of the other species, and as a matter of fact the form of branching is not identical. The inner clypeal hairs of *aconitus* (fig. 1, *f*) are more coarsely frayed and the outer hairs are frayed also instead of being simple or forked as in *filipinæ*. The tergal plates of *aconitus* (fig. 5, *a*) are smaller and more pointed, the anterior tergal hairs arise from the edge of or off the plate, and are typically two or three branched in the specimens examined. The characteristically pale proboscis of the female of *aconitus* is lacking in *filipinæ*.

I am therefore in agreement with Christophers and Puri in separating it as a distinct species.

Female.—Proboscis dark or with only an indefinite paling toward the tip; typical palpi (Plate 2, fig. 6) have the subapical black and white bands of nearly equal width and about half as wide as the apical white. The markings are subject to variation, however, and some specimens approach the typical *flavirostris* form while in others the subapical white is reduced to a very narrow band.

Wings (Plate 1, fig. 2) with a humeral white spot or a few white scales in 55 per cent of the specimens; presector white spots present in all; veins 2.1 and 2.2 occasionally with a few white scales or a definite spot centrally; vein 3 with dark spots near the crossvein and tip and with the central two-thirds of the vein white; vein 5.1 usually with a central white area; vein 6 with a fringe spot at its tip in a majority of specimens and with a white interruption on the apical half, producing three dark spots on the vein, in about one-fourth (27 per cent) of the specimens.

The form of the palpal banding, the frequent presence of a humeral white spot, of three dark spots on vein 6, the fringe spot at its tip and the absence of definite pale scaling on the proboscis distinguish the female from *flavirostris* in the ma-

jority of specimens. The same characters, with the exception of the humeral spot and the dark proboscis, apply to *mangyanus*.[10]

For identification based only on adult characters, specimens in fairly good condition are required and even then the determination will be doubtful in certain cases in which the typical combination of characters is lacking.

Male hypopygium.—Inner hair of the claspette (fig. 7, *e*) lacking in all specimens examined; outer hair similar to that of *flavirostris*.

Leaflets of the mesosome (fig. 8, *d*) slightly but apparently constantly shorter than those of the other local species; average length of longest leaflet, 30 μ, compared with an average of 36 μ for *flavirostris* and *mangyanus*.

Larva.—Inner clypeal hairs (fig. 1, *e*) finely frayed in all specimens examined except one and in this specimen one of the hairs was simple and the other had only one or two of the fine side branches; outer clypeal hairs unfrayed but frequently forked or trifid; posterior clypeal hairs usually branched from two to four times near the base, sometimes simple; the inner occipital hair typically 3-branched near the base, with variation of from 2 to 8 branches; outer occipital with similar variations; inner submedian prothoracic hairs (fig. 2, *c*) distinctly less branched than in the majority of var. *flavirostris* specimens, the average being 16.8, with variations from 12 to 22; leaflets of thoracic palmate (fig. 3, *b*) more or less intermediate in shape between *flavirostris* and *mangyanus* and more variable, usually tapering to a fine point or short filament; comparative length of filament of abdominal leaflets also intermediate—ratio to blade, 0.63 (Table 5); antepalmate hairs (see fig. 2, *g*) of segments 2, 3, and 7 almost invariably branched from the outer half, sometimes at the extreme tip, instead of from near the base as in *flavirostris*; tergal plates (fig. 5, *b*) of segment 1 comparatively broad and convex posteriorly; plate on segment 2 larger and also convex posteriorly instead of indented as in *flavirostris* and *mangyanus*; tergal plates on the other segments comparatively large and more rectangular in shape, the ends nearly as broad as the central portion; anterior tergal hairs arise

[10] Since the descriptions were written, it has been observed that *filipinæ* differs rather constantly from *mangyanus* in having small but definite pale spots at the apex of some of the tarsal segments, especially the first segment of the fore tarsi.

from the plates, well away from the edge as a rule, and are usually simple; small posterior (submedian) plates usually well chitinized and plainly visible.

The larvæ are much less pigmented subdermally than those of *flavirostris* or *mangyanus* and the tergal plates are not obscured as they frequently are in the other species. The larvæ are usually distinctly lighter in color than those of *flavirostris*.

The species was not identified in my collections of *minimus* from Negros or Mindanao. From the present records it appears to be the least common of the three species in central and southern Luzon and there is as yet no experimental evidence of its connection with the transmission of malaria.[11]

SUMMARY OF THE PRINCIPAL DISTINGUISHING CHARACTERS OF THE PHILIPPINE SPECIES OF THE FUNESTUS-MINIMUS SUBGROUP (WITH THE GENITALIC CHARACTERS OF THE TYPE FORMS OF FUNESTUS AND MINIMUS)

FEMALES

Anopheles minimus var. flavirostris.—Basal third of wing costa with one white interruption (the presector white spot), or entirely dark; subcostal white spot usually less than two-fifths the length of the subapical costal dark spot; vein 6 with one or two dark areas; fringe opposite the vein practically always dark. Proboscis with distinct pale scaling ventrally and laterally on apical half; palpi with the two distal white bands of about equal width and on an average twice the width of the intervening dark band.

Anopheles mangyanus.—Wings regularly with a double interruption on the basal third of the costa and usually with two dark spots on vein 6; fringe opposite vein 6 usually dark; subcostal white spot more than half the length of the subapical dark spot in the majority of specimens. Proboscis dark scaled; palpi fairly similar to var. *flavirostris* as a rule, sometimes without the dark subapical band. Apex of tarsal segments not pale scaled.

Anopheles filipinæ.—Basal third of costa with one or two white spots; vein 6 with two or three dark spots and usually with a

[11] In recent collections (April 1932) from one of the northern Provinces, however, *filipinæ* larvæ proved to be the predominating form in at least two places where malaria is highly prevalent. In these breeding places it was not particularly associated with growths of aquatic vegetation such as those referred to in an earlier part of the paper.

light fringe spot at the tip. Proboscis dark; palpi with the subapical white and dark bands of about equal width and usually about half that of the apical band. Apex of first tarsal segment of fore tarsi and usually some of the other tarsal segments with at least a few pale scales.

MALE HYPOPYGIUM

Anopheles minimus var. flavirostris.—A long inner claspette hair regularly present, of about the same size and length as the outer hair and two-thirds as long as the apical hair. Mesosomal leaflets of medium size, the longest leaflet having an average length of 36 μ.

Anopheles mangyanus.—Inner claspette hair usually lacking, or if present (2 of 17 specimens) may be short or associated with a duplication of the other hairs; outer and apical hairs similar to those of var. *flavirostris* and *filipinæ.* Leaflets of mesosome similar in size to var. *flavirostris* but more frequently number five on each side instead of four.

Anopheles filipinæ.—Inner claspette hair lacking. Mesosomal leaflets uniformly shorter than those of the two previous species; average length of longest leaflet, 30 μ.

Anopheles minimus (type form).—Inner claspette hair variable—a short hair may be present on one or both sides or lacking on both. Characters otherwise similar to var. *flavirostris.*

Anopheles funestus.—Inner claspette hair lacking or, if present (one of six specimens), very short; outer claspette hair very short and stout, less than half the length of the apical hair or club; the latter unusually large and expanded and nearly as long as the apical hair. Mesosome and leaflets unusually long; average length of longest leaflet, 49 μ.

LARVÆ

Anopheles minimus var. flavirostris.—Clypeal hairs simple and unfrayed, outer and posterior occasionally forked; the posterior hairs as a rule do not extend beyond the base of the inner (with the head in a horizontal position); inner submedian prothoracic hairs usually with more than 21 branches; leaflets of thoracic palmate tapered to a short point, without a filament; tergal plate of segment 1 narrow, oblong; plate of second segment deeply concave with the small median plate or a portion of the main plate detached; tergal plates on segments 3 to 7 usually convex posteriorly and narrowed toward ends; anterior tergal hairs (hair O) usually arise well away from the plate; antepalmate hairs (hair 2) of segments 2, 3, and 7

branched from the basal third; dorsal surface of larva with heavy subdermal pigmentation.

Anopheles mangyanus.—Clypeal hairs similar to the above except that the outer and posterior are longer, the latter extending to or nearly to the edge of the clypeus; inner anterior prothoracic hairs usually with from 18 to 23 branches; leaflets of thoracic palmate hairs with a fine filament; tergal plates of segments 1 and 2 similar to var. *flavirostris*, those of segments 4 to 7 with broader ends; small submedian plates usually chitinized; anterior tergal hairs usually arise from the tergal plate, sometimes near the edge either just on or just off the plate; antepalmate hairs of segments 2 and 3 usually branched from the middle third; antepalmate hair of segment 7 simple, or occasionally forked apically; larvæ pigmented dorsally with abundant spots of opaque white that are collected into submedian streaks on the thorax.

Anopheles filipinæ.—Inner clypeal hairs finely frayed, outer rather frequently forked or trifid; posterior usually branched two to four times from base; inner anterior prothoracic hairs usually with less than 21 branches; thoracic palmate hairs usually with a short, filamentous end; tergal plates of segments 1 and 2 broad and convex posteriorly; those of other segments very broad and oblong; tergal hairs deeply placed on plates. The larvæ are very sparsely pigmented and have only a few scattered spots of opaque white.

GENERAL SUMMARY

The *funestus-minimus* subgroup of *Anopheles* is represented in the Philippines by three species, one of which has previously been confused with the other two. This species appears to agree with the type specimen of *Myzomyia mangyana* Banks and also with that of *Myzomyia febrifera* Banks (both of which have always been regarded as synonyms of *Anopheles minimus*) and the name *Anopheles mangyanus* is provisionally assigned to it.

Comparative descriptions of the three species are given, together with new descriptive notes on the type forms of *Anopheles funestus*, *Anopheles minimus*, and *Anopheles aconitus*.

The Philippine form of *Anopheles minimus* differs in certain respects from specimens of the type form from China and its separation as a variety, or subspecies, under the name of *Anopheles minimus* var. *flavirostris* Ludlow, seems to be justified.

This is the best known of the three local species and during recent years has come to be considered the only Philippine *Anopheles* of serious importance in the transmission of malaria. Nearly all the evidence, however, has been obtained without distinguishing between the different members of the subgroup and it now appears that all three forms should be suspected as carriers until definitely proved otherwise. The probability that most of the experimental results with "*Anopheles febrifer*," reported by Walker and Barber in 1914, are attributable to *A. mangyanus*, as here defined, rather var. *flavirostris*, implies that this species is readily susceptible to infection with malaria parasites. In addition, *mangyanus* is found to occur in situations with which malaria is usually associated in the Philippines.

The third species, *Anopheles filipinæ* Manalang, appears in general to be the least plentiful of the three in central and probably in southern Luzon. While it has not previously been under suspicion as a carrier-species, recent observations in one of the northern provinces have shown it also to be abundant in places where the disease is unusually prevalent.

These species are small-stream breeders and all three occur on Luzon Island. Although preferences are shown for different types of breeding places, they are frequently more or less closely associated. In view of their morphological differences under these conditions it is evident that interbreeding does not normally occur and they must, therefore, be regarded as distinct species rather than varieties of one.

Certain differences in the male genitalia have been found in the five members of the subgroup of which male specimens are available, the examinations including the African *funestus* and the type form of *minimus* from China. The occurrence of unusually distinctive characters in the case of *Anopheles funestus* is further evidence of its specific differentiation from the Oriental species.

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ILLUSTRATIONS

[From camera lucida drawings.]

PLATE 1. FEMALE WINGS

FIG. 1. *Anopheles minimus* var. *flavirostris*, two wings.
2. *Anopheles filipinæ*, two wings.
3. *Anopheles mangyanus*, wing.

PLATE 2

FIG. 1. *Anopheles funestus*, wing.
2. *Anopheles minimus* var. *flavirostris* (two specimens), distal palpal bands.
3. *Anopheles minimus* (Hong Kong specimen), distal palpal bands.
4. *Anopheles funestus*, palpal bands.
5. *Anopheles mangyanus*, palpal bands.
6. *Anopheles filipinæ*, palpal bands.
7. *Anopheles aconitus*, palpal bands.
8. *Anopheles minimus* var. *flavirostris*, lateral view of the proboscis of two specimens, the second one representing the more typical appearance.

TEXT FIGURES

FIG. 1. Larval clypeal hairs; *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles mangyanus*; *c*, *Anopheles minimus* (type form); *d*, *Anopheles funestus*; *e*, *Anopheles filipinæ*; *f*, *Anopheles aconitus*.
2. Various larval hairs; *a*, submedian prothoracic hairs of *Anopheles minimus* var. *flavirostris*; *b*, bases of the submedian prothoracic hairs of *Anopheles funestus*, showing the type of fusion in this species; *c*, submedian prothoracic hairs of *Anopheles filipinæ*; *d*, inner (left) and outer occipital hairs of *Anopheles funestus*; *e*, inner occipital hair of *Anopheles minimus* var. *flavirostris*; *f*, antepalmate hair from abdominal segment II of *Anopheles minimus* var. *flavirostris*; *g*, the same of *Anopheles filipinæ*.
3. Thoracic palmate hairs (*a* to *c*) and leaflets of abdominal palmates from segment IV (*d* to *f*); *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles filipinæ*; *c*, *Anopheles mangyanus*; *d*, *Anopheles minimus* var. *flavirostris*; *e*, *Anopheles mangyanus*; *f*, *Anopheles filipinæ*.
4. Tergal plates; *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles mangyanus*.
5. Tergal plates; *a*, *Anopheles aconitus*; *b*, *Anopheles filipinæ*.
6. Tergal plates and examples of variations in the shape of plate II; *a*, *Anopheles minimus* (type form); *b*, *Anopheles funestus*.
7. Claspette hairs of male hypopygium; *a*, *Anopheles minimus* var. *flavirostris*; *b* and *c*, *Anopheles minimus* (type form), the second figure showing a short inner hair; *d*, *Anopheles mangyanus*; *e*, *Anopheles filipinæ*; *f*, *Anopheles funestus*.
8. Mesosomal leaflets; *a*, *Anopheles minimus* var. *flavirostris*; *b*, *Anopheles minimus* (type form); *c*, *Anopheles mangyanus*; *d*, *Anopheles filipinæ*; *e*, *Anopheles funestus*.

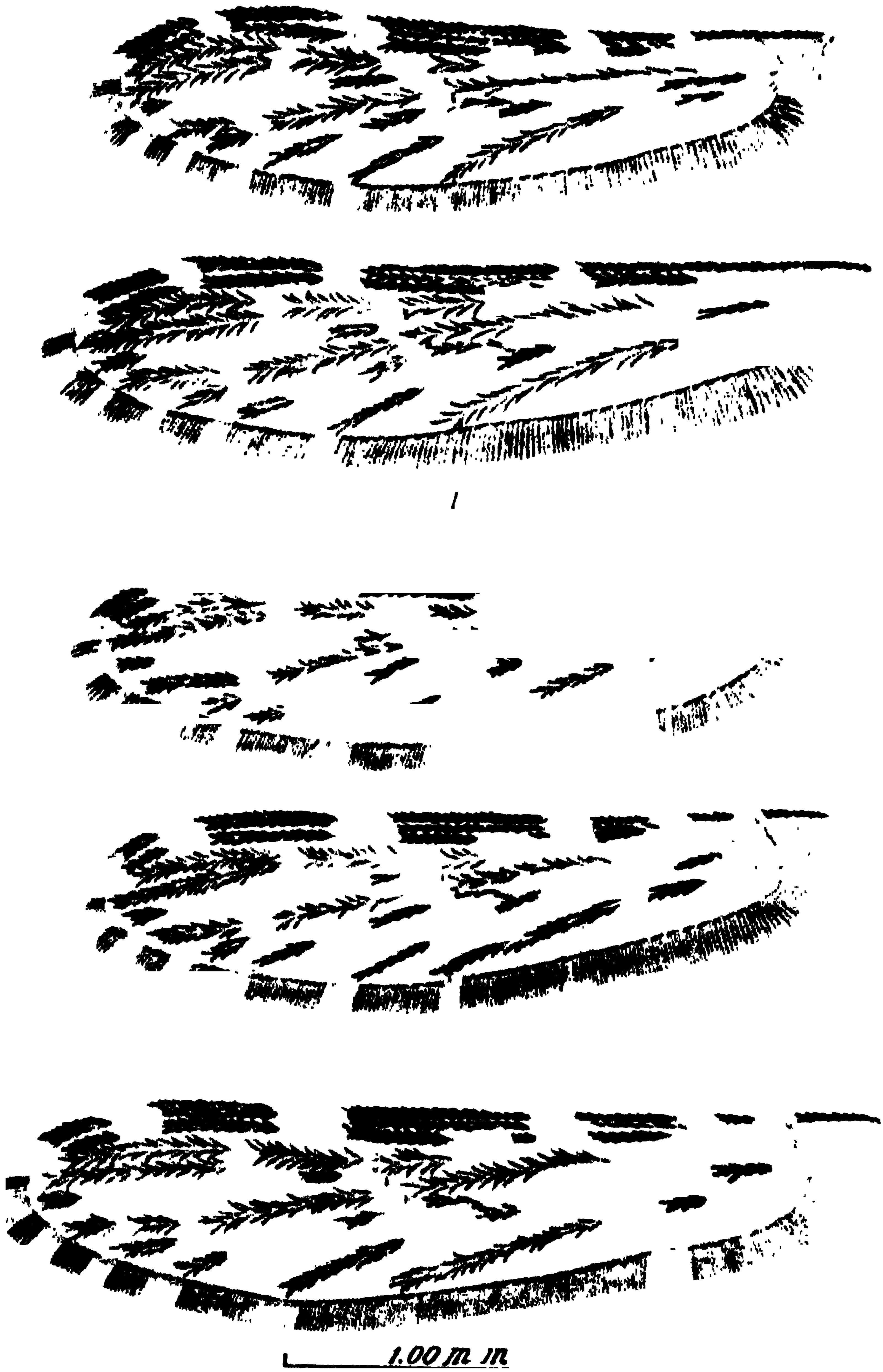
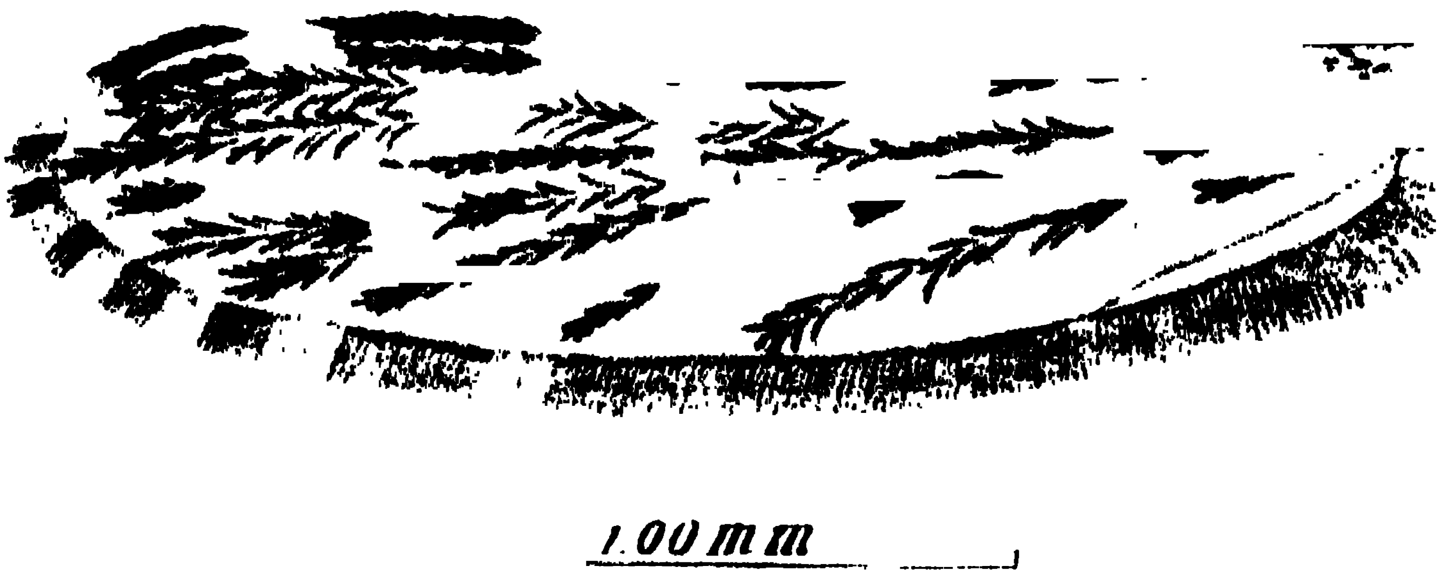


PLATE 1.



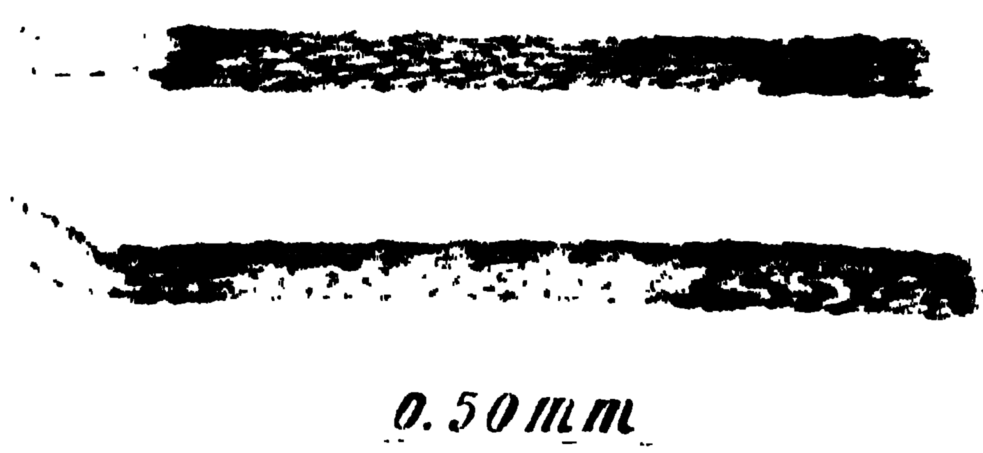


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PLATE 2.

MORE PHILIPPINE ISLANDS FRESH-WATER SPONGES

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FIVE TEXT FIGURES

INTRODUCTION

Some months ago the writer completed a restudy of the available materials of fresh-water sponges from the Philippine Islands and published a brief paper [1] summarizing our knowledge of the four known representatives of this group in the Islands up to that date. At the same time request was made for the collection of additional specimens from that region. We received, in response to this request, from R. C. McGregor, of the Philippine Bureau of Science, a collection of sponges that had been made by Francisco Rivera from Pasig River, between Pasig and Laguna de Bay, near Manila, in October, 1930. The very interesting collection consists of a number of small colonies most of which were found growing on plant roots, stems, or other similar small supports that had been submerged in the water. None of the colonies are very large and in many cases only the merest bits of sponge or bare layers of gemmules are present forming thin crusts of small area or covering the entire supports. Fortunately, nearly all of these were bearing gemmules.

The sponges in this collection represent four species, all of which are new records for the Philippine Islands, making now a total of eight species of fresh-water sponges, representing three genera, recorded from that region. Two of these new forms are *Spongillas*, one is an *Ephydatia*, and the other is a *Trochospongilla*.

Trochospongilla latouchiana var. *pasigensis* is a new variety of a form common in parts of India, Java, and China and it has been recently described in my monograph on the *Trochospongillas*.[2] A brief discussion of the points of difference be-

[1] Philip. Journ. Sci. 46 (1931) 61–75.

[2] Peking Nat. Hist. Bull. No. 2 6 (1931) 1–32.

tween this variety and the typical form, together with an illustration of the spicules of the new variety, is included in this paper. The three other forms are described in detail and are also illustrated in the following pages.

It is to be hoped that further collections of sponges from the fresh waters of the several islands will be made, for it is certain that other interesting forms will be found. The writer would be glad to study any additional specimens.

The records of occurrence of fresh-water sponges to date[3] are as follows:

1. *Ephydatia fortis* Weltner, 1895,
2. *Spongilla clementis* Annandale, 1909.
3. *Spongilla microsclerifera* Annandale, 1909.
4. *Spongilla philippinensis* Annandale, 1909.

The following additional forms were found in the above-mentioned collection:

5. *Spongilla tinei* sp. nov.
6. *Spongilla luzonensis* sp. nov.
7. *Ephydatia fluviatilis* var. *meyeni* (Carter), 1849.
8. *Trochospongilla latouchiana* var. *pasigensis* Gee, 1931.

SPONGILLA TINEI sp. nov. Fig. 1.

Historical statement.—In the collection mentioned above there are several specimens of this sponge. Some of them seem to have been collected dry and others show quite clearly evidences of having been taken fresh and living from the river. Specimen 54749 is used as the type for the description that follows.

Habitat.—Almost without exception these sponges were growing on the plant supports of various kinds which seem to be abundant in the river. They would doubtless have covered almost any kind of support available, however, and the specimens sent were those on plants since these were the most convenient kind for handling and transporting.

General characteristics.—This sponge forms a thin covering, the average one is only 3 or 4 millimeters thick, though one specimen measured as much as 1.25 centimeters in thickness on its supports, and in almost every case it is heavily laden with sand grains and other sediment. The surface of the sponge is very irregular due to the vertical fibers of the upper portion of the sponge projecting through the surface membrane in small sharp clusters. At times the sponge is barely thick enough to cover

[3] Philip. Journ. Sci. loc. cit.

the layer of gemmules attached to the stick; in other specimens it is thicker and the gemmules are crowded into the lower half of the sponge while the upper half is generally free of gemmules.

Color.—The body of the sponge would probably be almost a clear white if it were in clean water and free from sediment, for its individual fibers are often white when no foreign coloring matter is present. As it is full of sediment, however, it becomes a grayish color or even darker to almost black where the foreign matter caught in its meshes is abundant.

Structure.—The thinner specimens are composed of large irregular meshes which cover the single layers of gemmules and have no other definite distinguishing structure. The fibers which make up the meshes are bound together by an abundance of spongin and it often forms a film between the sides of the meshes. These films catch a good deal of sediment. In the thicker specimen the lower half of the sponge is similar to that just described and large numbers of gemmules are crowded into the meshes, but the upper portion of the sponge forms distinct, strong vertical fibers often composed of as many as eight or ten spicules firmly bound together. These fibers often extend beyond the surface of the sponge forming strong and sharp points. While there seems to be no definite system of transverse fibers, yet the vertical ones are bound strongly together by irregularly arranged short fibers or groups of spicules. When dry, the sponge is quite brittle and in making sections for study, it is easily shattered and the gemmules in the body of the sponge are dislodged in large numbers. The basal attachment of the specimens with layers of gemmules is quite solid and the gemmules are not readily shaken loose from the support in handling.

Skeleton spicules.—The skeleton spicules of this, as well as of the three other sponges found together in Pasig River, are in the main quite thin as compared with sponges of the same kind from other parts of the world. One wonders whether this is due to the small amount of silica available in the water or to the nature of the sponge itself. They are generally also slightly curved and smooth. Some of them are of a nearly uniform diameter throughout most of their length and become abruptly sharp pointed at their ends; others taper more or less gradually from the center to their ends forming fine, very sharp points. The central canal is visible in many of the spicules.

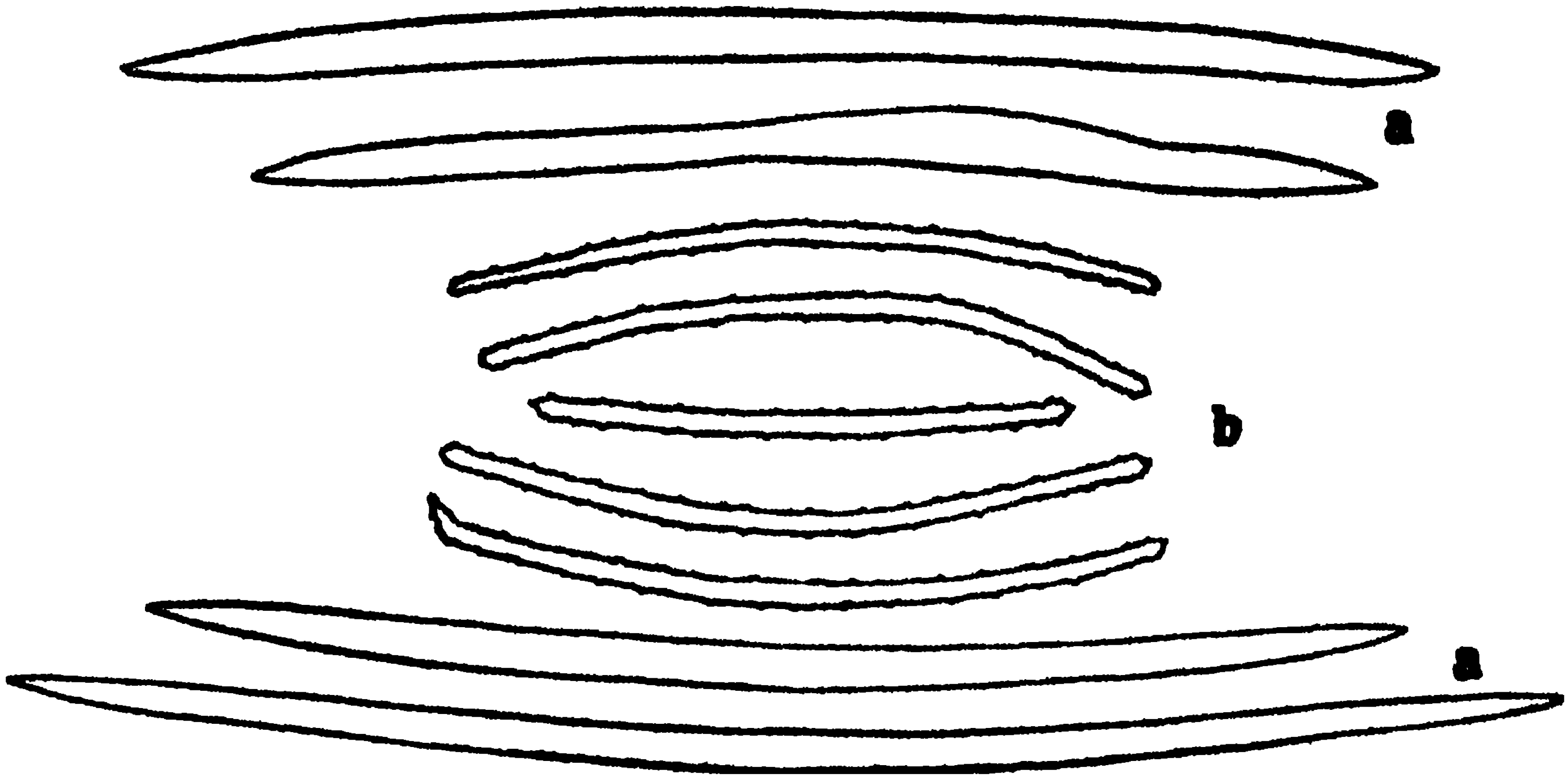


FIG. 1. *Spongilla tinei* sp. nov.; *a*, long slender skeleton spicules; *b*, finely spined gemmule spicules, with spines extending to the very ends; ends of spicules sometimes more finely drawn out than in the ones illustrated here.

Bulbous swellings are very common on these spicules in some of the specimens. The bulbs vary in number from one or two to six or even seven, and they are nearly always symmetrically placed along the axis of the spicules. When the number of swellings is odd, one is usually in the center and the others are similarly arranged on each side of it; when the number is even, the center usually has no swelling and the two ends bear similarly placed bulbs. A few of the spicules are much enlarged and bear large swellings, but frequently the swellings are small and occur on spicules of nearly normal dimensions.

The normal spicules (No. 54754) vary from 196 to 248 microns in length and from 4 to 10 microns in thickness. The larger numbers of spicules vary around about halfway between these extreme measurements.

Flesh spicules.—No flesh spicules were observed. A large number of very small, fine, smooth, sharp-pointed spicules are found in specimen 54759 along with the regular skeleton spicules. These are considered as young undeveloped skeletal spicules in the growing sponge and are not to be confused with flesh spicules.

Gemmules.—The somewhat flattened spherical gemmules are very abundant in all the specimens; they may occur singly or grouped in twos or threes with their bases together and the pore tubes projecting outward at the opposite side from the point of contact or they may occur in continuous layers in the base of the sponge entirely covering their supports or scattered

in groups or sometimes singly through the lower portion of the sponge. They are held in position by the meshwork of the sponge. In one case (No. 54755), they covered almost the entire area of a stick 1.5 centimeters in diameter and 17 centimeters long in one continuous layer. They are yellowish brown and are uniformly arranged with the single pore tube almost perpendicular to the support. The pore tube projects beyond the surface of the gemmule and the air-cell coat, which covers the entire surface of the gemmule, surrounds the tube with a chimneylike structure with gemmule spicules arranged in it at times both parallel to and at right angles to the length of the pore tube. The tube projects beyond this supporting structure and is dark brown, almost black, in color. The tube is very frequently curved. When the gemmules are bound together in groups, as often happens in the body of the sponge, the pore tubes project outward after the manner of those in typical *Spongilla fragilis*.

The gemmules are surrounded by a thick layer of polygonal air cells arranged symmetrically one above the other in such a manner that a columnar effect is the result, and it looks as if there is a series of contiguous, perpendicular columns surrounding it entirely. Within and on the surface of this covering the gemmule spicules are irregularly scattered, chiefly in a tangential position, almost never in a vertical one, except around the pore tube.

The gemmules (No. 54749) are moderately large ones, averaging around 430 microns in diameter; ranging from 425 to 468 microns.

Gemmule spicules.—The gemmule spicules are comparatively few in number and are very variable. Some are straight or almost straight with their ends more or less bluntly rounded; these are covered with very minute simple spines throughout their length with the spines in some cases somewhat thicker near the ends than in the central part of the spicule; others are curved, sometimes sharply curved near their ends, and are sharp pointed; these also bear numerous fine spines entirely covering them, frequently more numerous and larger near the ends, giving the end of the spicule a kind of spearhead appearance. Between these two extremes, all kinds of intermediate variations are found, some sharp at one end and blunt at the other, some almost bowed in shape. They vary (No. 54754) from 120 to 150 microns in length and from 2 to 4 microns in thickness.

Type.—The type is preserved in my collection as No. 54749. Cotypes are being deposited in several of the larger museums in other parts of the world.

Distribution.—This sponge is known only from the type locality, where it seems to have grown in great abundance.

Remarks.—The gemmule spicules of this sponge resemble somewhat the very fine ones of the *Spongilla fragilis* group,[4] but the gemmules are not grouped together in a common air-cell arrangement such as is common in the gemmules of that species.

This sponge (54749) resembles *Spongilla crassissima* var. *crassior* (54247)[5] in some respects but can be easily distinguished from it by the following characteristics. The gemmule spicules of *Spongilla crassissima* var. *crassior* are much heavier and bear larger spines; its gemmules are smaller, several are bound together and have a thicker covering layer of air cells and the pore tubes are comparatively longer and more curved than are those of *Spongilla tinei*. The skeleton spicules of *Spongilla crassissima* var. *crassior* are also very much heavier and have rounded ends, whereas those of *Spongilla tinei* are very much thinner and are very sharp pointed.

In some ways *Spongilla tinei* also resembles *Spongilla geei*, but the sponges of the latter species are much more massive and compact. The gemmule spicules of *Spongilla geei* are also in most cases much heavier and are more variable, while those of *Spongilla tinei* do not often vary beyond the two forms described above. The skeleton spicules of *Spongilla geei* are thicker and are usually abruptly pointed. The two sponges are quite distinct.

This Philippine sponge has been compared with many specimens of *Spongilla* and is so different from anything else in my collection or with which I am familiar that it is described as a new species.

SPONGILLA LUZONENSIS sp. nov. Fig. 2.

Historical statement.—These sponges form the larger numbers of specimens in the collection from Pasig River, Manila.

Habitat.—Most of these small sponges, as well as the others in the collection, were growing upon the submerged stems of

[4] Annandale, Fauna of British India: Fresh-water Sponges, Hydroids and Polyzoa (1911) 98–99.

[5] Gee, China Journ. of Sci. and Arts 4 (1926) 235–237.

small water plants or of other plants which had fallen in the water. One small specimen, the type (No. 54790), had grown around three or four small snail shells, the whole mass being about 2.5 centimeters long by about 1 centimeter in its thickest part.

General characteristics.—This sponge usually forms very thin films or crusts, rarely more than 1 to 2 millimeters in thickness, over the surface of the plant supports mentioned above. It may form small patches of a few centimeters in length on larger stems or at times it may even cover entirely the smaller twigs as much as 10 or 12 centimeters long and with a diameter of a few millimeters. It is frequently found growing together with other sponges on the same support and they are often badly mixed up. In this species, as was also the case with the others, some specimens are badly disintegrated as if they had been exposed for some time, while others bear the undisturbed film of the dried dermal membrane indicating that they were taken in a growing condition from the water. The surface of the sponge is usually smooth with no protuberances or other outgrowths from it.

Color.—The sponge itself is almost black, due to the very large amount of sediment which is present in it. The gemmules are dirty white or gray. The amount of sediment in the water is evidently large and this accounts for the color of the specimens.

Structure.—The thin film of sponge (No. 54763) is made up of a rather irregularly arranged series of meshes of varying sizes. The sides of these thin fibers are without any definite arrangement and, when dry the sponge is very fragile. Frequent small-pointed groups or clusters composed of a few spicules bound together by spongin project above the surface of the sponge in the fresh, uninjured specimens.

Skeleton spicules.—The skeleton spicules (No. 54790) are very thin, generally slightly curved, rarely altogether straight. Most of them are smooth, though now and then one bearing very fine spines only visible under high powers of the microscope may be found. They are gradually and very sharply pointed; sometimes bulbous enlargements are found at the center of the spicule. Very often the central canal is clearly visible. They vary from 212 to 238 microns in length and from 3 to 6 microns in thickness.

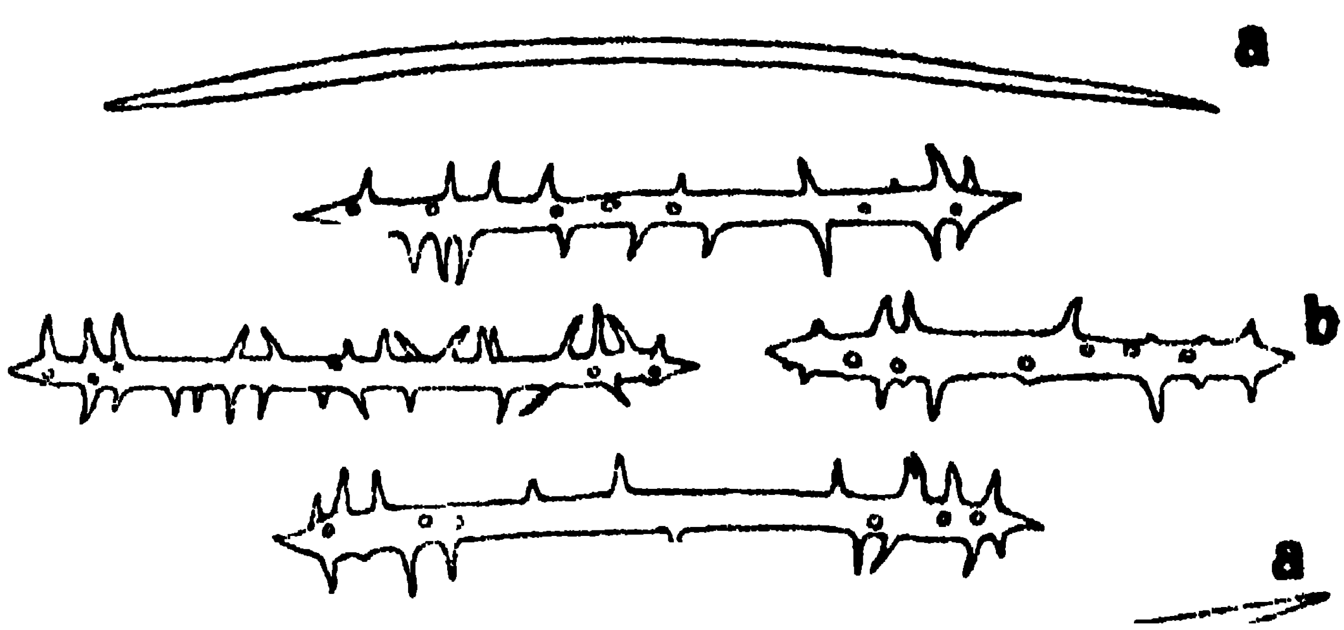


FIG. 2. *Spongilla luzonensis* sp. nov; *a*, very slender, finely pointed skeleton spicules; *b*, typical gemmule spicules bearing heavy spines throughout their length; the lowest one shows fewer spines near the center of the spicule.

Flesh spicules.—No flesh spicules were observed in this species.

Gemmules.—The gemmules are very abundant and form layers in the base of the sponge on the support; they occur singly and though they are often so thick as to be in actual contact they are not united together in groups as is the case in the other species, *Spongilla tinei*, just described in this article. The gemmules are covered by the thin layer of sponge and are inclosed in the meshes of which it is composed. In color, they are white when clean, but all too often they become dirty white or gray due to the large amount of foreign matter contained in the water. In shape, the gemmules are spherical with a projection of the surface of the coat covering the gemmule around the single pore tube into a rounded knob or umbo, or at times a cone-shaped elevation, out of the center of which emerges the small brown pore tube itself. The pore tube is usually curved and may frequently be nearly twice as long as the gemmule spicules. In the projection surrounding the pore tube the gemmule spicules are often arranged in a chimneylike fashion around the tube with their length perpendicular or at right angles to the length of the tube. A single layer of perpendicularly arranged gemmule spicules tightly bound together by granular spongin covers the gemmule as a protecting coat. The gemmules are rather small, they measure from about 212 to 273 microns in their normal diameter; this measurement includes also the perpendicular layer of gemmule spicules surrounding the gemmule.

Gemmule spicules.—The gemmule spicules of this species are small and slender and are very variable. They may be straight or gently curved. There are found now and then cylindrical spicules abruptly sharp pointed and with only one or several spines; others may be thickly covered with spines of varying size, from very fine ones to others with a length equal to or longer than the diameter of the spicule itself, throughout its entire length except on the sharpened ends of the spicule. The spines nearest the end are usually longest and more numerous, they are only very rarely entirely absent in the center of the spicule. The spines are usually simple, straight, and perpendicular to the spicule axis; sometimes, but rarely, a few spines may be found obliquely placed, no hooked or curved ones have been observed. In some cases there are several large spines arranged around the end of the spicule at the base of the terminal spine or sharpened end, in one case a spicule with such spines ended bluntly and the large spines united at their bases resembled an imperfect retule. This was observed in only one or two instances and is not by any means a characteristic of the species; it is rather an exception. These spicules are quite distinct from the *Ephydatia crateriformis* group.

The ordinary spicules vary from about 50 to 62 microns in length and from 2 to 3 microns in thickness. A few much longer spicules were observed, but they were doubtless unusual and abnormal ones.

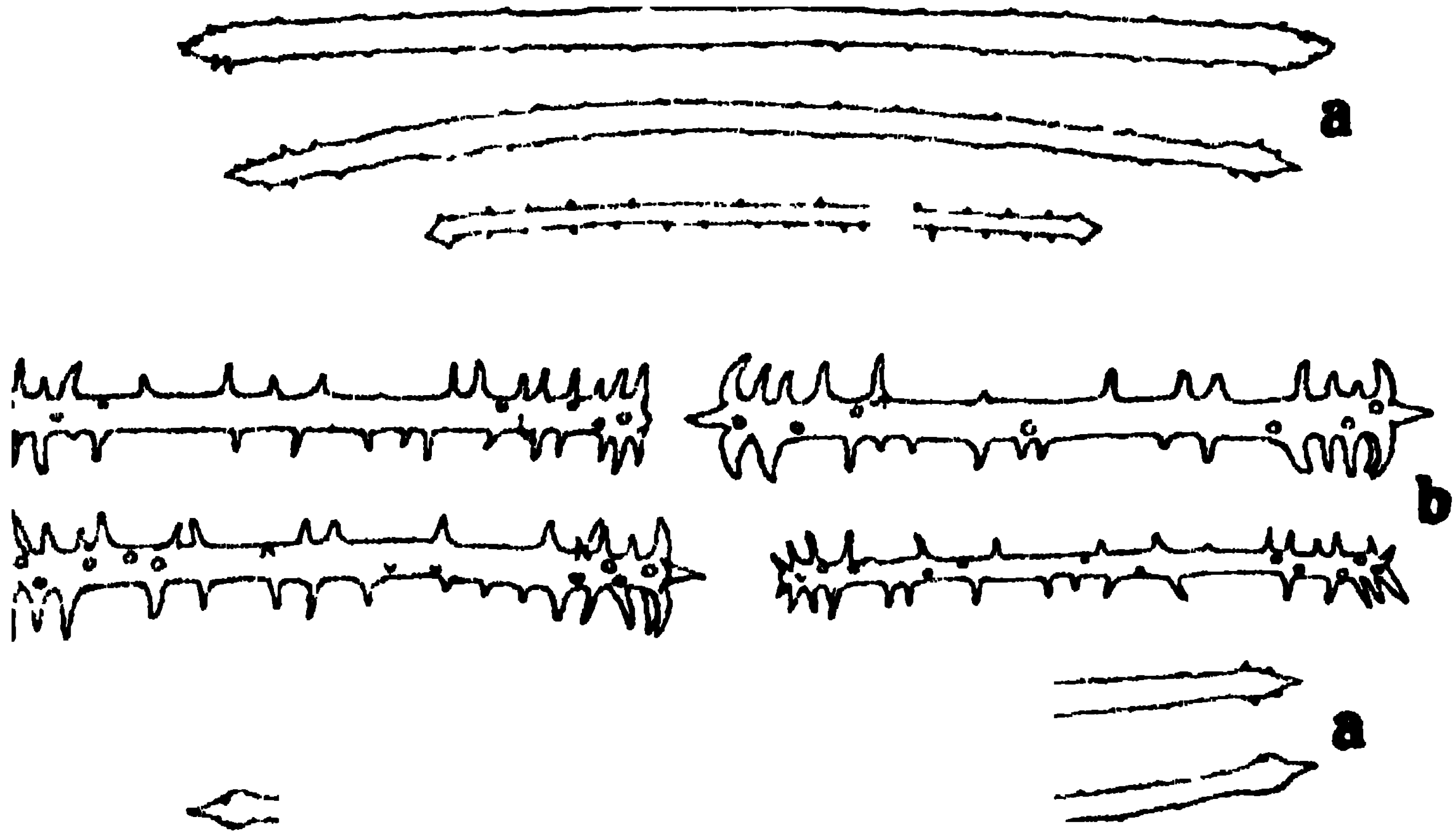


FIG. 3. *Ephydatia crateriformis* (Potts); *a*, finely spined skeleton spicules typical of this Indian sponge; the spear-shaped ends differ very decidedly from the typical form found in the United States: *Spongilla lusonensis*, has no such spicules; *b*, some of these gemmule spicules resemble somewhat those of *S. lusonensis*, but this sponge has many more spines and the ends are definitely surrounded by whorls of spines forming distinct rotules.

Type.—The type of this species is (No. 54970) in my collection. Cotypes are being deposited in several of the larger museums in other parts of the world.

Distribution.—This species is known only from Pasig River, near Manila, Philippine Islands.

Remarks.—There is some resemblance between *Spongilla hemephydatia* [6] and this species, but the differences between the two species are so marked that they can be readily distinguished.

(1) In the first place the gemmules of *Spongilla hemephydatia* are heavier in structure and are nearly twice as large. They range from 365 to 425 microns in diameter, while those of *Spongilla luzonensis* are only 212 to 273 microns.

(2) The gemmule spicules of *Spongilla hemephydatia* average a little longer and a little thicker than those of *Spongilla luzonensis.* They are from 60 to 63 microns in length and from 4 to 6 microns in thickness. The spines of *Spongilla hemephydatia* are usually smaller and much thicker than in the other form; they are also differently arranged; they are clustered around the ends (see Annandale, fig. 12) and if the spicule ends in a spine it is simply one of the small ones common around its end, not the spicule terminating in a sharpened point.

(3) The skeleton spicules of *Spongilla hemephydatia* are longer and thicker, 297 to 331 by 10 to 14 microns, than those of the Philippine sponge.

Spongilla luzonensis resembles most closely in a number of respects the sponge described by Annandale in 1907 as *Ephydatia indica* (fig. 3) and later in 1911 [7] as *Ephydatia crateriformis* and illustrated in fig. 13, A.

(1) The gemmule spicules of the Philippine sponge, *Spongilla luzonensis,* are similar to the sharp-pointed ones illustrated, in fig. 13, A; but as a rule they are not so thickly spined, the spines are larger, and the end of the spicule is more markedly a sharpening of the spicules rather than simply a large terminal spine. In only most rare cases is there a whorl of spines around the end of the spicules of *Spongilla luzonensis* as is the case with many of the spicules of Annandale's sponge *Ephydatia crateriformis.*

[6] Annandale, Fresh-water Sponges, etc., in Fauna of British India (1911) 82–83, fig. 12.

[7] Annandale, op. cit. 83–86, fig. 13.

(2) The gemmules of the two sponges have several points of resemblance, but those of the Indian sponge are considerably larger.

(3) The skeleton spicules of the two sponges are markedly different. Those of *Spongilla luzonensis* are generally smooth and sharp pointed, only rarely in a spicule found incipiently spined, the spines being so small that high magnification is needed to render them visible. Those of the Indian sponge are all clearly spined, they may have rounded, sharpened, or spear-shaped ends.

For the reasons enumerated above, this sponge is considered a new species.

EPHYDATIA FLUVIATILIS var. MEYENI (Carter), 1849. Fig. 4.

Spongilla meyeni Carter, 1849.
Ephydatia fluviatilis Weber, 1890.
Ephydatia mülleri Weltner (part), 1895.
Ephydatia robusta Annandale, 1907.
Ephydatia mulleri var. *meyeni* Annandale, 1908.

Habitat.—The several specimens of this species in the collection were all growing on living or dead plant stems of varying sizes which were submerged in the water of Pasig River. It is understood that the water of this river is very rich in organic matter since it serves as the receptacle for a good deal of the waste from the City of Manila.

General characteristics.—None of the specimens of this sponge are larger than those of the two species of *Spongilla* found with them; some form very thin crusts of only a few millimeters in thickness along their supports, covering them for a few centimeters in length. One of the largest pieces is a lump growing attached to a minute rootlet; it is about 6.5 centimeters long by about 3 centimeters thick in its thickest part. The surface is irregular, showing no special distinguishing structural characteristic, though it is perforated by many small pores. While in most specimens there are no protuberant growths except as they grow around branches of the plant, yet there are one or two specimens which have small and short rounded elevations upon their surfaces. The gemmules are grouped in a layer in the base of the sponge and attached upon the supports; or in the tuberous outgrowths, the gemmules are crowded together near the center of the sponge. In some of the specimens (all

of which are dry) the remains of a dermal membrane still persist, though in most cases it has already disappeared. Since my specimens are all dry, I am not able to observe whether or not the bubble cells are present in the parenchyma.

Color.—In color the sponge is grayish yellowish on the inner areas and this seems to have a decided greenish tinge on the outer parts of the majority of the specimens. Some of the bits that have grown in water more heavily laden with dark sediment are almost black.

Structure.—The basal portion of the sponge next to its support is composed of a rather open network with irregular meshes. The gemmules covered with a few skeleton spicules are often lodged singly in these meshes. The meshes are formed by fibers varying in thickness, some containing only three or four spicules to thicker ones, at times with as many as seven or eight to twelve or even more spicules. The amount of spongin present in this portion of the sponge is small. The outer portion of the skeleton is composed of the thicker fibers and radiating ones can be found, though they are not so clearly defined as are these fibers in *Ephydatia fluviatilis*, common in certain localities in China. These longer fibers are bound together by irregular cross fibers forming an irregular meshwork. The amount of spongin in the upper portion of the sponge is larger than in the basal part and the structure is therefore much more rigid there.

Skeleton spicules.—The mature skeleton spicules are slender, prevailingly smooth, usually slightly curved, rarely straight, of more or less uniform thickness, tapering rather abruptly to sharp points at the ends. The immature spicules are very thin, gradually and sharply pointed at both ends. Scattered throughout the skeletal structure are frequently found in some of the specimens (No. 54760) larger, thicker spicules which have from one to several bulbous enlargements at intervals along their length. These are probably abnormalities and are of no special significance. At times, also, spicules are found bearing fine spines varying in number and size. The regular skeleton spicules range from 187 to 272 microns in length, the usual length is about 235 microns, and from about 6 to 12 microns in thickness.

A specimen of *Ephydatia meyeni* (Carter) (No. 53437) from the British Museum has very much larger and thicker spicules, they measure from 348 to 425 microns long and from 18 to 22 microns in thickness.

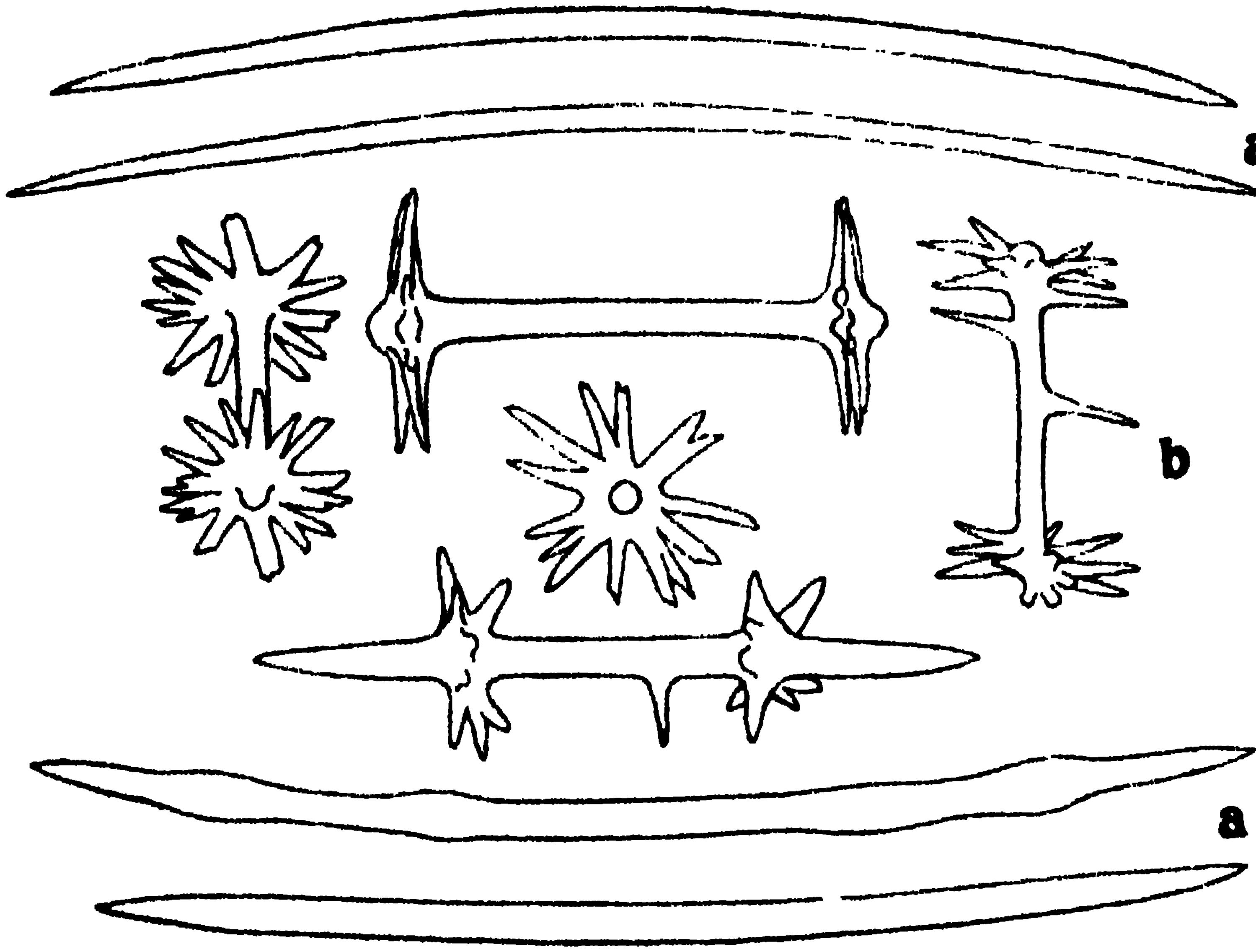


FIG. 4. *Ephydatia fluviatilis* var. *meyeni* (Carter); *a*, smooth skeleton spicules, some of them bear bulbous enlargements regularly placed at intervals along the axis of the spicule; *b*, very irregular gemmule spicules, birotulates, some with smooth shafts, others bearing spines; some show toothlike projections out of the regular plane of the rotule; the lowest one shows the shaft extended at both ends beyond the rotule or disk; this is very common in these sponges.

Flesh spicules.—This species does not have any flesh spicules.

Gemmules.—The gemmules are spherical in shape, but the outer surface of the covering coat is very irregular and uneven. Often they are shrunken in, forming bowl-like structures when they are dry. They are brownish in color and occur singly, but are grouped into layers near the center of the sponge or upon the support; they are held in position within the skeleton meshes by a thin irregular lot of spicules attached to the outer area of the coat surrounding the gemmule. The covering birotulates are arranged in layers, usually more than one, with their shafts perpendicular to the surface of the gemmule. The inner layer of birotulates is quite regular, the second layer is thinner and more irregular, while the remains of a third very irregular layer are found in many of the gemmules as single more or less isolated birotulates here and there over the surface. This is in rather decided contrast with the single, regularly arranged layer of birotulates which forms the covering of typical *Ephydatia fluviatilis*.

The pore tube is a simple, straight one ending on the surface of the gemmule coat. The gemmules are fairly large, often

reaching as much as 575 microns when the outer edges of the coat are included. The usual range in size is from about 425 to 575 microns; when denuded of the covering the gemmule measures about 390 microns.

Gemmule spicules.—The gemmule spicules are variable in length, ranging from 22 to 46 microns in the various specimens measured. The shaft ranges between 4 and 6 microns in diameter, and the rotules, both of which are of about the same diameter, measure from 16 to 28 microns. While in the majority of cases the shafts are smooth, yet now and again rather large sharp spines, at times equalling in length the radius of the rotule or longer, are present; these may number one, two, or even three, but not often more. The shaft forms a distinct umbo beyond the disks, and frequent abnormal forms with the shaft projecting into sharpened extensions of varying lengths at one or both ends are found. The rotules are deeply and irregularly incised; they often bear one or more teeth projecting from the general plane of the disk. The rotules are at times replaced by a bulbous enlargement, which is covered by heavy spines projecting at various angles in addition to the plane of the regular rotule.

The gemmule spicules of *Ephydatia meyeni* (No. 53437), a specimen from India, are somewhat larger and of a more-uniform length than those of the Philippine sponge and they also have more spines on their shafts. The spines are frequently provided with minute secondary spines near their tips.

Type.—The type of *Ephydatia fluviatilis* var. *meyeni* (Carter) is preserved in the British Museum.

Distribution.—Carter's type of this sponge was found on Bombay Island, and the species has since been collected in Calcutta, Cape Comorin, and Bhim Tal in India. Weber found it in Sumatra and the writer has collected it in Soochow, China. This collection from Pasig River, Luzon, extends the range of distribution quite a good deal.

Remarks.—Annandale [8] states that this *Ephydatia meyeni* can be distinguished from *Ephydatia fluviatilis* by the following characters:

1. There are bubble cells in the parenchyma of *Ephydatia meyeni*, they are lacking in *Ephydatia fluviatilis*.
2. The skeleton of *Ephydatia meyeni* has more spongin and is more compact than that of *Ephydatia fluviatilis*.

[8] Annandale, op. cit. (1911) 242.

3. The gemmule spicules of *Ephydatia meyeni* are shorter than those of *Ephydatia fluviatilis*.
4. The gemmules of *Ephydatia meyeni* are covered by more than one layer of birotulates, while those of *Ephydatia fluviatilis* have only one regularly arranged row embedded in pneumatic tissue with minute air spaces.

1. Since my specimens are all dry I cannot discover any bubble cells in the parenchyma of these sponges. 2. The amount of spongin present in a sponge is so variable under different conditions of growth that this alone is hardly an adequate basis for distinction of a species. 3. The length of the gemmule spicules of this sponge is such a variable quantity that I have found specimens with the shaft actually shorter than the diameter of the rotules; this is rare, however, for most of them have shafts decidedly longer than the diameter of the rotule but the length is very far from a constant quantity. Both *Ephydatia meyeni* and *fluviatilis* have such a range in the variations of the birotulates that it would be difficult to separate these two forms on such a basis. 4. This leaves then the only satisfactory basis of separation of the two forms to be by means of the layers of birotulates covering the gemmule. This seems to be fairly constant and is a reason for distinction between the two sponges. Such a slight difference does not deserve specific distinction, however, and I am placing *meyeni* as a variety of *Ephydatia fluviatilis*. While the Pasig River sponge varies a good deal from the typical form of this variety, yet its range of variation connects up fairly well with the type and the multiple rows of gemmule spicules clearly place it within this variety.

The skeleton spicules of the Philippine representative of this sponge are very much thinner than those of the Bombay, India, specimen, but all of the sponges in the entire collection from Pasig River seem to produce comparatively small skeleton spicules. This may be due to a lack of an adequate supply of the proper materials in this river for the formation of the more-robust types of spicules such as are found in other localities.

TROCHOSPONGILLA LATOUCHIANA var. PASIGENSIS Gee, 1931. Fig. 5.

Historical statement.—This new variety of *Trochospongilla latouchiana* was found in the collection of sponges sent me by Mr. McGregor. Just at the time a small monograph on the known sponges of this genus was being prepared and the origin-

al description of this sponge was recorded there. The points[9] of difference between this variety and the typical form are summarized below.

DISTINGUISHING CHARACTERISTICS

Skeleton spicules.—The skeleton spicules of the Philippine variety, *pasigensis,* are shorter and thinner than those of the type form. The spicules of this variety measures from 150 to 189 microns long by 3 to 5 microns thick, while those of the typical form range from 220 to 310 microns long by 8 to 18 microns in thickness.

Gemmules.—The gemmules of the variety average slightly smaller than those of the type form. The gemmules of the variety *pasigensis* range from 170 to 180 microns in diameter, while those of the type form are from 178 to 230 microns in diameter.

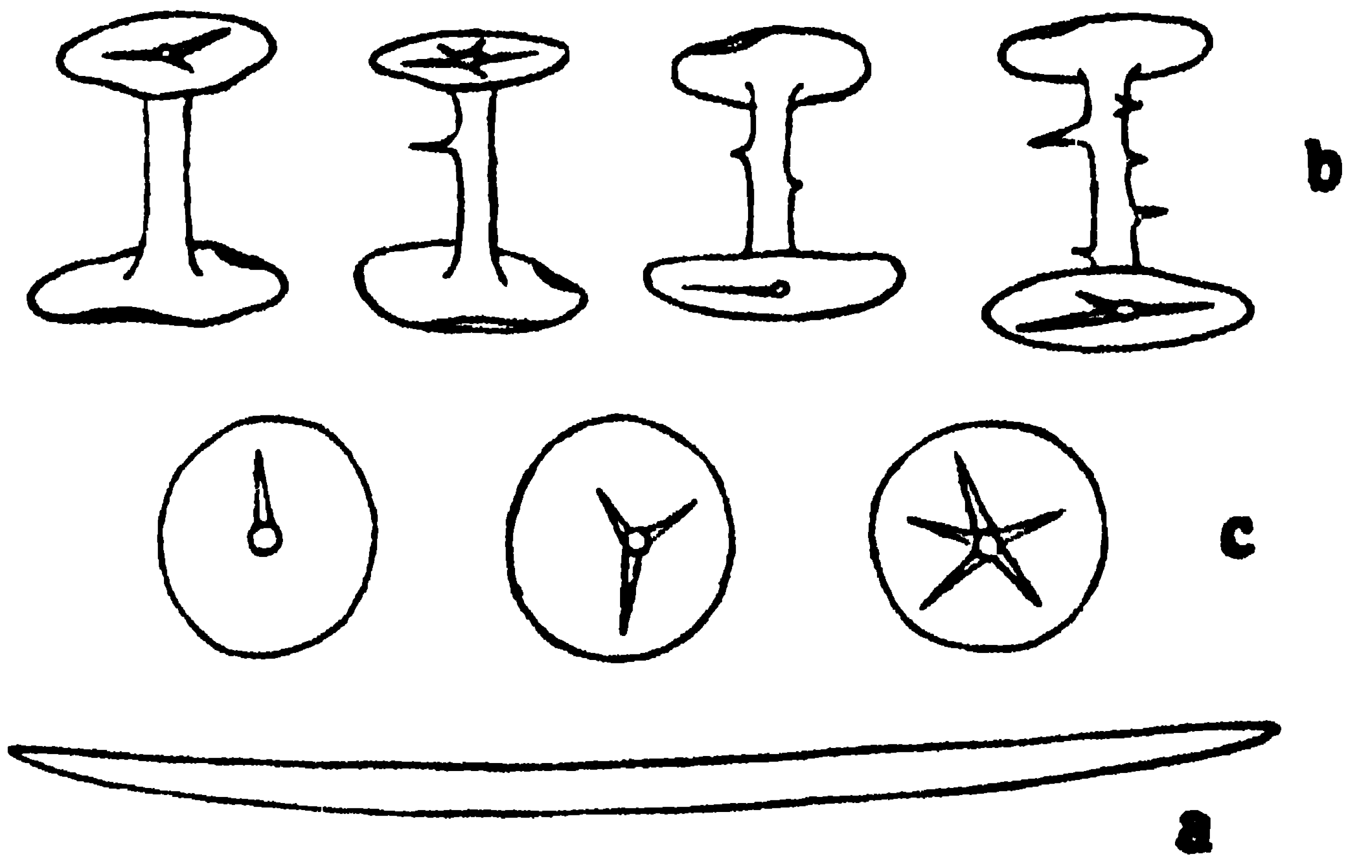


FIG. 5. *Trochospongilla latouchiana* var. *pasigensis* Gee; *a*, skeleton spicules; *b*, gemmule spicules with spined shafts; this condition is not found in the sponges of the type form in India, China, or Java; *c*, on the surfaces of the disks are often found thickened elevations radiating from the center of the disk; these vary in number from one to several.

Gemmule spicules.—The gemmule spicules are very variable, and the following are some of the points in which they differ from the type form:

[9] Gee, Peking, Nat. Hist. Bull. pt. 2 6, (1931–32) 1–32.

SHAFT

1. The variety often bears one or more spines on its shaft; we have never found a spine on the type form.
2. The shaft of the Philippine sponge sometimes projects beyond the rotule forming a long sharp spine. No such condition has ever been observed in the type form.
3. The shaft of the variety is sometimes decidedly curved. This has not been observed in the type form.

ROTULES

1. In the variety the rotules sometimes occur at an oblique angle, instead of the usual right angle, to the shaft.
2. In the variety the rotules, especially the larger ones, often have very heavy radiating ridges upon their lower surfaces, these ridges being largest and thickest near the base of the shaft, becoming thinner and pointed as they near the edge of the disk. The number of these ridges on each may vary from one or two to as many as five or six. The presence of these thickened ridges sometimes gives the disk the appearance of being incised around the edges, but this has not yet been found to be the case in any instance.

Type.—The type from which this variety has been described is preserved in my collection as No. 54784.

Distribution.—This is the only *Trochospongilla* yet found in the Philippine Islands and it has been found only in the type locality.

ILLUSTRATIONS

[I am indebted to Mr. Li, artist in the Department of Anatomy, Peiping Union Medical College, for four of the drawings illustrating this article.]

TEXT FIGURES

FIG. 1. *Spongilla tinei* sp. nov.; *a*, long slender skeleton spicules; *b*, finely spined gemmule spicules, with spines extending to the very ends; the ends of spicules are sometimes more finely drawn out than in the ones illustrated here.

2. *Spongilla luzonensis* sp. nov.; *a*, very slender finely pointed skeleton spicules; *b*, typical gemmule spicules bearing heavy spines throughout their length; the lowest one shows fever spines near the center of the spicule.

3. *Ephydatia crateriformis* (Potts); *a*, finely spined skeleton spicules typical of this Indian sponge; the spear-shaped ends differ very decidedly from the typical form found in the United States; *Spongilla luzonensis* has no such spicules; *b*, some of these gemmule spicules resemble somewhat those of *S. luzonensis*, but this sponge has many more spines and the ends are definitely surrounded by whorls of spines forming distinct rotules.

4. *Ephydatia fluviatilis* var. *meyeni* (Carter); *a*, smooth skeleton spicules, some of them bear bulbous enlargements regularly placed at intervals along the axis of the spicule; *b*, very irregular gemmule spicules, birotulates, some with smooth shafts, others bearing spines; some show toothlike projections out of the regular plane of the rotule; the lowest one shows the shaft extended at both ends beyond the rotule or disk; this is very common in these sponges.

5. *Trochospongilla latouchiana* var. *pasigensis* Gee; *a*, skeleton spicules; *b*, gemmule spicules with spined shafts; this condition is not found in the sponges of the type form in India, China, or Java; *c*, on the surfaces of the disks are often found thickened elevations radiating from the center of the disk; these vary in number from one to several.

PARIS GREEN PARTIALLY ADSORBED ON CHARCOAL AS A LARVICIDE FOR ANOPHELES MOSQUITOES
LARVICIDE STUDIES, II [1]

By AUGUSTUS P. WEST
Of the Bureau of Science, Manila

and

PAUL F. RUSSELL
Of the International Health Division of the Rockefeller Foundation

TWO PLATES

In a previous article [2] charcoal was suggested as a diluent for Paris green mixtures prepared in the usual way for the destruction of anopheles larvæ. In this paper charcoal is considered not as a diluent in a mixture but as an actual support, or vehicle, with the Paris green adsorbed and carried into the gut of the anopheles larva. The essential difference between charcoal mixed with Paris green and Paris green adsorbed by charcoal is that approximately only one particle in a hundred of a 1 per cent Paris-green mixture is poisonous to the mosquito larva, whereas every granule of charcoal treated with 1 per cent Paris green (adsorbed) carries its load of the toxic substance. Theoretically, a larva "brushing" in the midst of a floating Paris-green mixture ingests 99 grains of an innocuous substance to 1 grain of Paris green. If its breeding place is dusted with the charcoal powder having adsorbed Paris green then every grain ingested contains some poison.

CHARCOAL AS A SUPPORT FOR PARIS GREEN

Wood charcoal is very durable and is not affected by water. For this reason charred stakes driven into moist ground are

[1] These studies were undertaken by the Bureau of Science, divisions of organic chemistry and of malaria investigations. The latter is coöperatively supported by the Bureau and by the International Health Division of the Rockefeller Foundation.

[2] Russell, P. F., and A. P. West, Philip. Journ. Sci. (in press).

more lasting than ordinary stakes; casks, when charred inside, preserve water much better than common casks because they furnish no soluble matter for fermentation. The ancients wrote with inks made from ground charcoal. Their writings found in the ruins of Herculaneum have retained their original blackness for over two thousand years. Inscriptions on tomb stones in old churchyards are still well preserved though the white lead used in painting the carbon-black letters is entirely destroyed.[3]

Porous wood charcoal has the property of absorbing large volumes of gases. It also can remove from aqueous solution various coloring matters, alkaloids, and metallic salts.[4]

In a previous paper[5] it was noted that charcoal has good floating qualities; it is visible after application, easily powdered, and not expensive. Another important quality is its suitability for ingestion by anopheles larvæ. The photographs reproduced herewith give visible evidence of the rapidity with which the gut of an anopheles larva is filled with larvicidal charcoal when the powder is dusted on the surface of the water in relatively small amounts. The larvæ obviously have no aversion to the charcoal and not the least difficulty with its ingestion.

APPLICATION OF PARIS GREEN TO CHARCOAL

The charcoal used in this investigation was powdered sufficiently fine to pass a 50-mesh sieve.

Adsorption of the Paris green and other substances on the charcoal was carried out in the following manner: The charcoal (5 grams) was placed in a beaker and the required amount of Paris green, necessary to make the concentration desired, was then added. The mixture was treated with about 60 cubic centimeters of water, stirred thoroughly, and heated to a temperature of about 90° C. The mixture was then transferred to an evaporating dish and evaporated to dryness. The residue was scraped from the dish and powdered. A sample of larvicidal charcoal prepared in this manner and consisting of 1 part of Paris green to 99 parts of charcoal was regarded as containing 1 per cent of Paris green.

As Paris green alone is rather insoluble in water this treatment gives only a partial adsorption of the Paris green on the

[3] Thorpe, E., Dictionary of Applied Chemistry 1 (1912) 663.

[4] Watts, Dictionary of Chemistry 1 (1927) 686.

[5] Russell, P. F., and A. P. West, Philip. Journ. Sci. (in press).

charcoal. By this procedure the Paris green is partly adsorbed by the charcoal while a portion is simply mixed with the charcoal. The expense of this operation consists essentially in the cost of evaporating the mixture. During the dry season this could be accomplished by means of sunlight thus requiring only the cost of labor.

EXPERIMENTS WITH PARIS GREEN-ADSORBED CHARCOAL

The tables present the results of our laboratory experiments to determine the larvicidal effects of Paris green partially adsorbed on charcoal. In all of these studies a uniform technic has been used for testing this action of larvicide on anopheles mosquitoes. It must be stressed that it is vital in such studies to use standardized methods, with proper controls, to avoid misleading results.

EXPERIMENTAL PROCEDURE

In each of these experiments the same type of rectangular enamel pan was used, the same amount and kind of fresh artesian water, the same method of timing and of removing the dead larvæ. Various but comparable weights of the charcoal larvicide were used, adequate controls were provided, and the same technician assisted at the experiments. Even with all due caution the results of such a biological study are likely to show considerable variation. Others, for example Shannon and Frobisher,[6] have noted the wide differences in the reaction of mosquito larvæ to a larvicide. Individual larvæ differ in their resistance to Paris green. Even using the same development stages of the same species this variation is noted.

The pans used in these experiments were such that the water in them had a surface area of 532 square centimeters and a depth of 5 centimeters. The larvæ in most of the tests were taken from collections in which the predominating species were *A. subpictus* and *A. hyrcanus* var *sinensis*. Those used in the experiments were not individually identified before use in order to avoid the possibility of injury from handling under a microscope. After the experiment an examination was made to confirm the diagnosis of the species. When the larvæ had been counted into the pans the larvicide was blown uniformly over the surface. At the end of each observation period, motionless larvæ were touched gently with a dissecting needle. If a larva

[6] Am. Journ. Hyg. 14 (1931) 437.

made any response whatever, even a very slight contraction, it was not removed. If, however, it could not be stimulated it was removed to a small beaker of water and observed until the end of the experiment to make certain that it had actually been dead at the time it was removed from the pan. Larvæ sometimes recover after showing all appearance of death as reported, for example, by Barnes.[7] In these experiments we rarely found it necessary to return a larva to the pan again.

RESULTS

In Table 1 are given the results of a series of tests on the larvicidal effects of charcoal treated with Paris green and oxalic acid in various concentrations. This combination kills anopheles larvæ quite effectively. It is interesting to note that when the percentage of Paris green is 35 (test 19), the lethal effects of the combination in twenty-four hours are no greater than when the percentage is 7 (test 25). Earlier deaths occur, however, in the stronger combinations. The best results in this series were obtained using 0.1 gram of a 3 per cent Paris green combination (test 80). Ross and Edie[8] tried oxalic acid with indifferent success against culex larvæ. Bodine[9] reported that the larvæ of *Culex pipiens* were resistant to high concentrations of salicylic, oxalic, hydrochloric, butyric, and acetic acids.

When lime instead of oxalic acid was used with Paris green on the charcoal the larvicidal effect was slightly enhanced (Table 2). Very low concentrations of Paris green (tests 94 and 95) proved to be as efficacious as the standard mixtures of Paris green and diluent, 1 to 100, as ordinarily used. (See the table in our first paper[10] for comparison. For example, a concentration of only 0.1 per cent Paris green (test 95) killed 100 per cent of the larvæ in twenty-four hours. Usual field practice as recommended by Hackett[11] requires 1,250 grams of Paris green per hectare (0.125 gram per square meter or 0.0000125 gram per square centimeter). For an area of 532 square centimeters, as in this experiment, this practice would require 0.00665 gram of Paris green or 0.665 gram of the 1 per cent mixture. Actually in test 95 (Table 2), using only 0.1 gram of

[7] Am. Journ. Hyg. 5 (1915) 315.
[8] Ann. Trop. Med. & Parasit. 5 (1911) 385.
[9] Biol. Bull. Marine Biol. Lab. Brooklyn, N. Y. 45 (1923) 149.
[10] Russell, P. F., and A. P. West, Philip. Journ. Sci. (in press).
[11] Trans. 1st. Internat. Congress Malaria, Rome (1925) 158.

the 0.1 per cent larvicidal adsorbed charcoal, there was only 0.0001 gram of Paris green present to kill the larvæ. Had the same relative amount of powder by weight been used as is recommended for field use, the amount of Paris green present in this 0.1 per cent combination would have been 0.000665 gram.

For comparison, in tests 29 and 23 (Table 2), plain lime, and also charcoal treated with plain lime (adsorbed), were used with little effect on the larvæ. Osborn[12] experimented with lime as a larvicide against aëdes larvæ. So also did Paterson.[13] The latter reported it to be potent against culicine larvæ.

In Table 3 are presented the results of tests with Paris green and borax adsorbed on charcoal. In test 93, shown in this table, sodium carbonate was used instead of borax. The results of these tests indicate that borax is not so effective as lime in combination with Paris green, although borax itself has been used as a larvicide.[14]

In Table 4 are given the results of a series of tests in which Paris green and small amounts of arsenic trioxide together with either lime or borax were adsorbed on the charcoal. Very low concentrations of Paris green were used with good effect in some tests. For example, in tests 110, 129, and 134, the percentage of Paris green was only 0.05, with an equal amount of arsenic trioxide.

In Table 5 are given the results of some miscellaneous tests with charcoal treated with Paris green and other substances, for comparison with Tables 1 to 4.

In Table 6 are given the results of some later experiments in which three-fifths of the larvæ used were *Anopheles minimus*, the malaria-carrying species of the Philippines. In these tests the other larvæ were *A. fuliginosus* and *A. philippinensis*. In all of the tests *A. minimus* larvæ were the first to succumb.

SUMMARY

It would appear from the tests discussed in this paper that charcoal treated with small amounts of Paris green (partially adsorbed) has a pronounced lethal effect on anopheles larvæ.

Low concentrations of Paris green, less than 1 per cent, proved to be as efficacious as the standard 1 per cent mixtures of Paris green and diluent as ordinarily used.

[12] Ind. Med. Gaz. 41 (1906) 498.
[13] S. African Journ. Sci. 22 (1925) 311.
[14] Matheson, R., and E. H. Hinman, Am. Journ. Hyg. 8 (1928) 293.

TABLE 1.—*Larvicidal effects of Paris green and oxalic acid partially adsorbed on charcoal.*

Test No.	Substance used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time periods. Cumulative totals.														Weight of larvicide.
				Minutes.								Hours.						
				15	30	45	60	75	90	105	120	2.5	3	4	5	6	24	
		Per cent																*g.*
12	Control (nothing)		50	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
24	do.		50	0	0	0	0	0	0	0	0	0	0	0	2	2	2	
11	Control; plain charcoal		50	0	0	0	0	0	0	0	0	0	0	0	0	2	6	0.13
5	Paris green Oxalic acid	3 1	52	0	0	0	0	0	0	2	2	18	58	74	86	96	100	0.13
30	Paris green Oxalic acid	3 1	50	0	0	0	0	0	6	20	44	68	76	86	98	100	100	0.1
6	Paris green Oxalic acid	3 2	50	0	0	0	0	0	0	2	2	8	18	52	68	76	86	0.13
7	Paris green Oxalic acid	4 2	50	0	0	0	0	2	2	10	10	24	56	76	98	98	98	0.13
14	Paris green Oxalic acid	4 2	48	0	0	0	0	0	0	0	0	2	6	60	80	84	92	0.01
8	Paris green Oxalic acid	6 2	50	0	0	0	0	0	4	4	6	14	20	50	60	74	92	0.13
25	Paris green Oxalic acid	7 1	30		0		0		7		13	28	46	70	93		100	0.01
15	Paris green Oxalic acid	12 4	50	0	0	0	2	4	4	12	22	46	72	94	96	98	100	0.01
16	Paris green Oxalic acid	15 3	50	0	0	0	2	2	2	2	10	22	54	64	94	96	96	0.01
17	Paris green Oxalic acid	20 3	50	0	0	0	2	6	6	8	18	26	50	88	90	90	90	0.01

18	Paris green Oxalic acid	25 5	50	0	0	0	6	8	12	16	28	60	74	90	96	96	96	0.01
19	Paris green Oxalic acid	35 5	50	0	0	0	2	4	6	10	14	40	54	92	94	94	94	0.01

TABLE 2.—*Larvicidal effects of Paris green and lime partially adsorbed on charcoal.*

Test No.	Substance used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time periods. Cumulative totals. Minutes. 15	30	45	60	75	90	105	120	Hours. 2.5	3	4	5	6	24	48	72	Weight of larvicide.
		Per cent																		g.
24	Control (nothing)		50	0	0	0	0	0	0	0	0	0	0	0	2	2	2			
95	Paris green Lime	0.1 0.5	50	0	0	0	0	0	0	0	2	20	58	80	88	94	100			0.1
94	Paris green Lime	0.8 0.3	50	0	0	0	0	0	0	0	2	2	4	20	52	52	100			0.1
28	Paris green Lime	3.0 1.0	29		0		3		22		38	65	79	93	95		100			0.13
39	Paris green Lime	3.0 1.0	50	0	0	0	0	0	14	22	44	68	76	86	94	94	98			0.13
81	Paris green Lime	3.0 1.0	50	0	0	0	0	14	30	80	92	98	100	100	100	100	100			0.1
27	Paris green Lime	4.0 2.0	30		0		0		30		57	77	87	97	97		100			
26	Paris green Lime	7.0 1.0	30		0		0		3		20	23	51	77	90		100			0.01
29	Lime	10.0	50	0	2	2	2	2	2	2	2	2	2	2	2	2	4	4	10	0.18
23	Lime, plain		50	0	0	0	0	0	0	0	0	0	0	2	2	2	4			0.13

TABLE 3.—*Larvicidal effects of Paris green and borax partially adsorbed on charcoal.*

Test No.	Substance used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time periods. Cumulative totals. Minutes. 15	30	45	60	75	90	105	120	Hours. 2.5	3	4	5	6	7	24	48	72	Weight of larvicide.
			Per cent.																		*g.*
140	Control (nothing)		50	0	0	0	0	0	0	0	0	0	0	2	2	2		2			
96	Paris green	0.5	50	0	0	0	0	0	0	0	0	0	0	6	30	38	42	94			0.1
	Borax	0.5																			
123	Paris green	0.5	50	0	2	4	6	6	6	6	12	14	18	34	44	58	62	96			0.665
	Borax	0.5																			
97	Paris green	0.8	50	0	0	0	0	0	2	2	2	2	4	10	24	48	70	96			0.1
	Borax	0.4																			
124	Paris green	0.8	50	0	0	0	0	0	0	0	0	8	8	36	46	50	66	94			0.665
	Borax	0.4																			
142	Paris green	0.8	50	0	0	0	0	0	0	0	0	0	8	16	24			92			0.1
	Borax	0.4																			
98	Paris green	0.8	50	0	0	0	0	2	4	4	6	12	18	28	54	60		100			0.1
	Sodium carbonate	0.8																			
166	Borax	2.0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6			0.1

TABLE 4.—*Larvicidal effects of Paris green, arsenic trioxide, and lime (or borax) partially adsorbed on charcoal.*

Test No.	Substance used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time periods. Cumulative totals. Minutes. 15	30	45	60	75	90	105	120	Hours. 2.5	3	4	5	6	7	24	48	72	Weight of larvicide.
		Per cent.																			g.
108	Control (nothing)		50	0	0	0	0	0	0	0	0	0	0	0	0	0		0			
130	do.		50	0	0	0	0	0	0	0	0	0	0	0	0	0		8			
	Paris green	0.5																			
63	Arsenic trioxide	2.0	48	0	0	0	0	2	2	2	4	14	24	44	72	81	85	96			0.18
	Lime	0.1																			
	Paris green	0.5																			
90	Arsenic trioxide	0.5	50	0	0	0	0	2	2	12	20	38	56	80	90	96	96	100			0.1
	Lime	0.5																			
	Paris green	0.5																			
110	Arsenic trioxide	0.05	50	0	0	0	0	0	0	0	0	0	0	0	2	12	18	76	76	82	0.1
	Borax	0.1																			
	Paris green	0.05																			
129	Arsenic trioxide	0.05	50	0	0	0	0	0	0	0	0	0	0	0	2	6	24	94			0.665
	Borax	0.1																			
	Paris green	0.05																			
134	Arsenic trioxide	0.05	50	0	0	0	0	0	0	0	0	0	0	0	18	26		88			0.33
	Borax	0.1																			
	Paris green	0.3																			
96	Arsenic trioxide	0.3	50	0	0	0	0	0	0	0	0	0	6	32	42	58	68	96			0.1
	Borax	0.3																			
	Paris green	0.3																			
125	Arsenic trioxide	0.3	50	0	0	0	0	0	2	8	16	20	24	68	76	84	94	100			0.665
	Borax	0.3																			

TABLE 4.—*Larvicidal effects of Paris green, arsenic trioxide, and lime (or borax) partially adsorbed on charcoal*—Ctd.

Test No.	Substance used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time period. Cumulative totals. Minutes. 15	30	45	60	75	90	105	120	Hours. 2.5	3	4	5	6	7	24	48	72	Weight of larvacid
		Percent.																			*g.*
	Paris green	0.3																			
131	Arsenic trioxide	0.3	50	0	0	0	0	2	2	2	2	16	24	50	68	76	----	88	----	----	0.33
	Borax	0.3																			
	Paris green	0.3																			
143	Arsenic trioxide	0.3	50	0	0	0	0	2	2	2	2	4	8	30	60	----	----	96	----	----	0.1
	Borax	0.3																			
	Paris green	0.4																			
99	Arsenic trioxide	0.4	50	0	0	0	0	0	0	0	0	0	0	16	24	38	46	100	----	----	0.1
	Borax	0.4																			
	Paris green	0.4																			
147	Arsenic trioxide	0.4	50	0	0	0	2	2	2	2	2	2	6	38	46	----	----	96	----	----	0.1
	Borax	0.4																			
	Paris green	0.5																			
91	Arsenic trioxide	0.5	50	0	0	0	0	4	10	18	30	42	50	80	90	96	96	100	----	----	0.1
	Borax	0.5																			
	Paris green	0.7																			
100	Arsenic trioxide	0.7	50	0	0	0	0	0	0	0	0	0	8	58	66	96	96	100	----	----	0.1
	Borax	0.7																			
	Paris green	0.7																			
144	Arsenic trioxide	0.7	50	4	4	4	4	4	4	4	4	4	36	72	82	----	----	100	----	----	0.1
	Borax	0.7																			
	Paris green	1.0																			
102	Arsenic trioxide	1.0	50	0	0	0	0	0	0	0	0	0	0	40	90	90	92	96	----	----	0.1
	Borax	1.0																			

109	Paris green Arsenic trioxide Borax	0.1 0.1 0.2	50	0	0	0	0	0	0	0	0	0	0	2	6		14	78	80	88	0.1
128	Paris green Arsenic trioxide Borax	0.1 0.1 0.2	50	0	0	0	0	0	0	0	2	4	8	12	18	18	22	80	----	----	0.665
133	Paris green Arsenic trioxide Borax	0.1 0.1 0.1	50	0	0	0	0	0	0	0	0	0	2	10	18	32	----	94	----	----	0.33
107	Paris green Arsenic trioxide Borax	0.2 0.2 0.2	50	0	0	0	0	0	0	0	0	0	4	10	22	42	54	96	----	----	0.1
108	Paris green Arsenic trioxide Borax	0.2 0.2 0.4	50	0	0	0	0	0	0	4	0	0	4	14	26	52	62	96	----	----	0.1
126	Paris green Arsenic trioxide Borax	0.2 0.2 0.2	50	0	0	0	0	0	0	4	4	8	16	40	68	68	70	96	----	----	0.665
127	Paris green Arsenic trioxide Borax	0.2 0.2 0.4	50	0	0	0	0	0	0	0	2	12	34	50	60	64	84	94	----	----	0.665
132	Paris green Arsenic trioxide Borax	0.2 0.2 0.2	50	0	0	0	0	0	0	0	0	8	12	28	48	66	----	98	----	----	0.33
145	Paris green Arsenic trioxide Borax	0.2 0.2 0.2	50	0	0	0	0	0	0	0	0	0	0	6	6	----	----	46	----	----	0.1
149	Paris green Arsenic trioxide Borax	0.2 0.2 0.2	50	0	0	0	2	2	4	4	4	4	12	18	20	----	----	84	----	----	0.1

TABLE 5.—*Larvicidal effects of Paris green and other substances partially adsorbed on charcoal.*

Test No.	Substances used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time periods. Cumulative totals. Minutes. 15	30	45	60	75	90	105	120	Hours. 2.5	3	4	5	6	7	24	48	72	Weight of larvicide.
		Per cent.																			g.
119	Control (nothing)	------	50	0	0	0	0	0	0	0	0	0	0	0	0	0	----	0	----	----	----
64	Paris green Arsenic trioxide Sodium carbonate	0.5 2.5 0.2	49	0	0	0	0	0	0	0	12	20	48	60	80	88	94	100	----	----	0.12
89	Paris green Arsenic trioxide Sodium carbonate	0.5 2.5 0.2	49	0	0	0	0	4	28	55	66	79	84	96	100	100	100	100	----	----	0.1
71	Paris green Arsenic trioxide Sodium carbonate	1.0 3.0 1.0	48	0	0	0	0	0	0	0	----	----	----	----	----	----	----	88	----	----	0.12
72	Paris green Arsenic trioxide Sodium carbonate	1.0 3.0 2.0	49	0	0	0	0	0	0	2	2	4	8	14	18	30	----	94	----	----	0.12
73	Paris green Arsenic trioxide Sodium carbonate	1.5 3.5 1.5	49	0	0	0	0	0	4	6	10	20	32	48	52	54	----	100	----	----	
92	Paris green Arsenic pentoxide Borax	0.5 0.5 0.5	50	0	0	0	0	0	0	2	16	32	64	68	78	84	----	96	----	----	0.1
65	Paris green Arsenic trioxide Lime Sodium carbonate	0.5 2.5 0.2 0.2	50	0	0	0	0	0	0	2	4	18	54	64	72	76	92	100	----	----	0.12

70	Paris green Arsenic trioxide Sodium bicarbonate	1.5 3.5 1.5	48	0	0	0	2	2	2	4	-----	-----	-----	-----	-----	-----	-----	89	-----	-----	0.13
114	Paris green Rotenone hydrobromide	0.2 0.4	50	0	0	0	0	0	0	0	0	0	0	4	16	26	40	76	-----	-----	0.1
117	Paris green Arsenic trioxide Derris root Borax	0.05 0.1 0.1 0.3	50	0	0	0	0	0	0	0	0	2	2	2	2	6	6	22	-----	-----	0.1
118	Paris green Arsenic trioxide Derris root Borax	0.05 0.1 0.2 0.3	50	0	0	0	0	0	0	0	0	0	0	0	0	0	10	84	-----	-----	0.1

TABLE 6.—*Larvicidal effects of Paris green partially adsorbed on charcoal, when used against A. minimus fuliginosus, and philippinensis (three-fifths A. minimus).*

Test No.	Substances used.	Concentration.	Number of larvæ used.	Percentage of dead larvæ in time periods. Cumulative totals. Minutes. 15	30	45	60	75	90	105	120	Hours. 2.5	3	4	5	6	7	24	48	72	Weight of larvicide.
		Per cent.																			*g.*
187	Control (nothing)		50	0	0	0	0	0	0	0	0	0	0	2	2	2	2	4	8		
	Paris green	0.05																			
177	Arsenic trioxide	0.05	50	0	0	0	0	0	0	0	0	0	0	0	2	8	18	72	92		0.8
	Lime	0.5																			
	Paris green	0.1																			
	Lime	0.5									0						20	50	84		
	Paris green	0.1																			
	Arsenic trioxide	0.1									0						30	54	98		
	Borax	0.2																			
	Paris green	0.2																			
182	Arsenic trioxide	0.2									2				58	60	62	96	98		
	Borax	0.2																			
181	Paris green	0.5	50								0		20	36	48	56	62	90	100		
	Borax	0.5																			
	Paris green	0.5																			
186	Arsenic trioxide	0.5	50								4		4	26	42	58	70	100			
	Lime	0.5																			
	Paris green	0.7																			
179	Arsenic trioxide	0.7	50								30	44	44	52	64		80	100			
	Borax	0.7																			
184	Paris green	0.8	50									18	34	50	68		84	98			
	Lime	0.3																			
178	Paris green	1.0	50									38	42	61	72		88	100			
	Lime	0.5																			

Combinations of Paris green and borax partially adsorbed on charcoal were not as effective as Paris green and lime.

Combinations of Paris green and arsenic trioxide partially adsorbed on charcoal in very low concentrations (much less than 1 per cent) were used with good effect in some tests.

Some tests were carried out with larvæ of different species; namely, *Anopheles minimus*, *A. fuliginosus*, and *A. philippinensis*. In these tests the larvæ of *A. minimus* were the first to succumb.

ILLUSTRATIONS

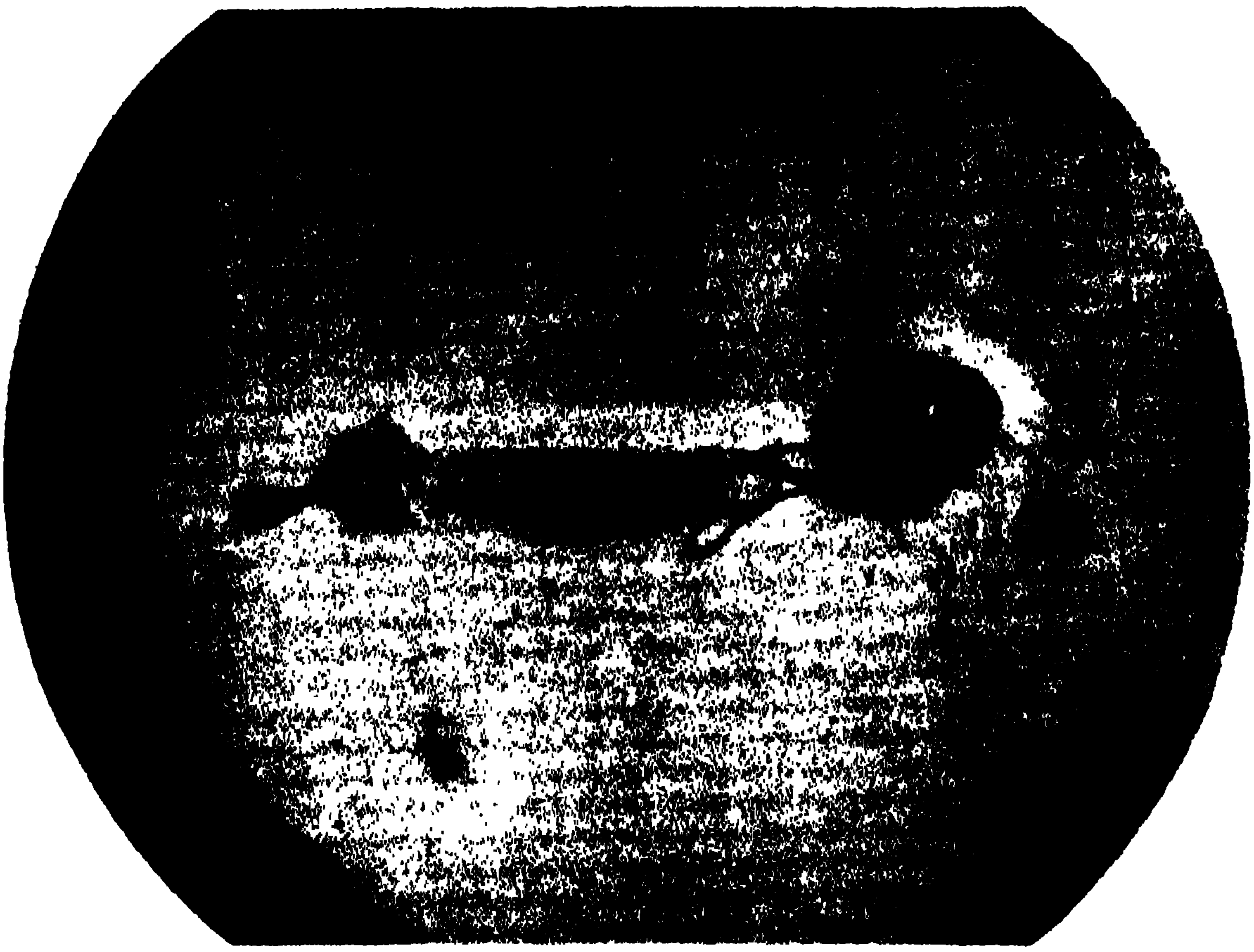
[The photographs show the gut of larva of *A. philippinensis* dissected out after feeding. The larva had begun to feed in a pan with 0.1 gram of larvicidal charcoal distributed evenly over a surface area of 532 square centimeters. The photographs show the gradual filling of the gut in a period of ninety minutes.]

PLATE 1

FIG. 1. After feeding ten minutes.
2. After feeding fifteen minutes.

PLATE 2

FIG. 1. After feeding thirty minutes.
2. After feeding sixty minutes.
3. After feeding ninety minutes.



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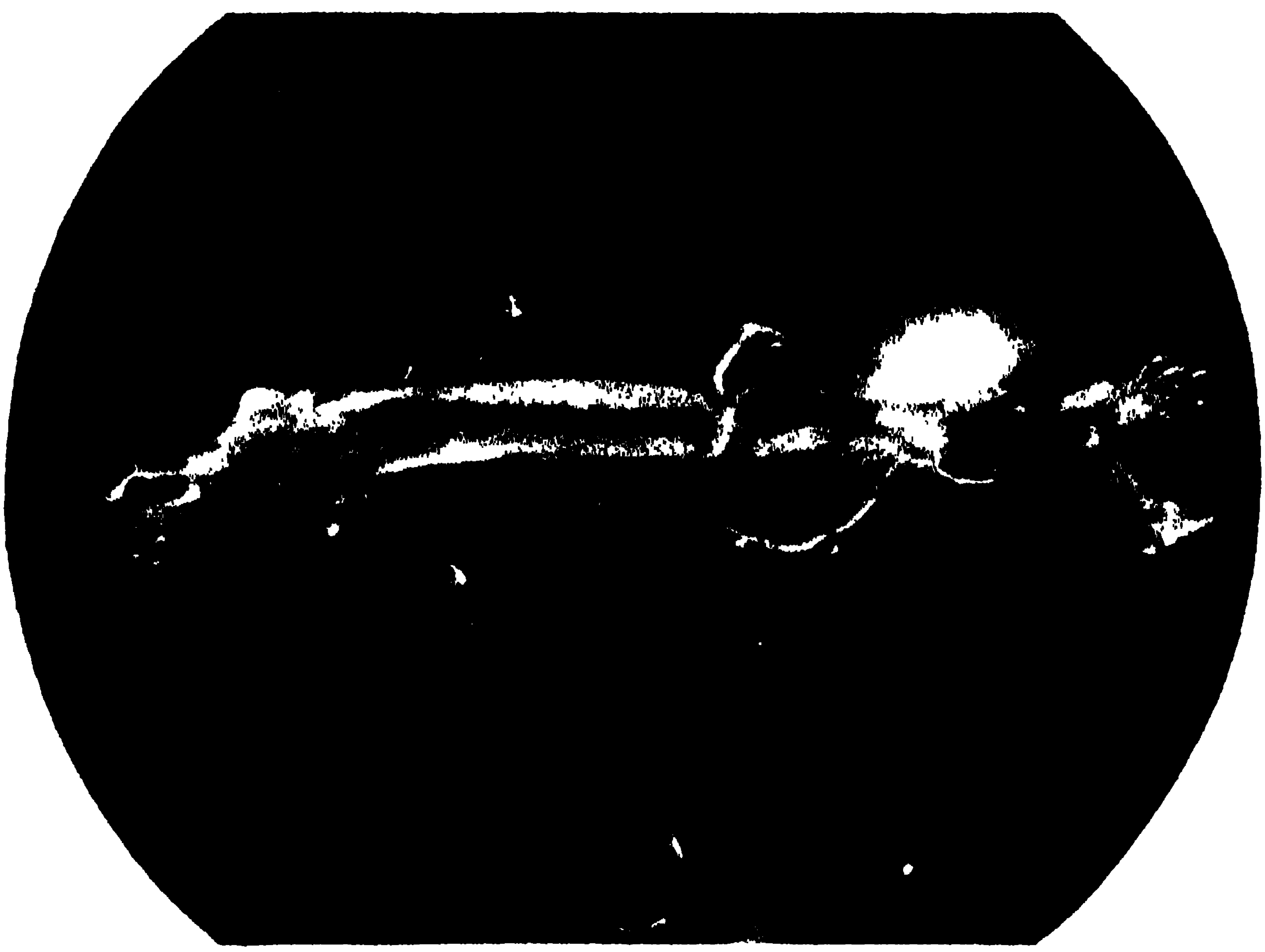

2

PLATE 1.

1

3

PLATE 2.

MORPHOLOGICAL AND CHEMICAL STUDIES ON THE SEEDS OF ERYTHRINA VARIEGATA VAR. ORIENTALIS (LINNÆUS) MERRILL [1]

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and

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SIX PLATES

Erythrina variegata var. *orientalis* (Linn.) Merr., locally known as *dap-dap*, is a deciduous plant occurring along the seashores of the Philippines; frequently, however, it is cultivated. This plant is one of the four species of *Erythrina* so far found in this country.

Plants of the genus *Erythrina* have been shown to contain alkaloidal constituents of varying physiological effects. For example, Bochefontaine and Rey [2] found the aqueous extract of the bark of *E. corallodendron* Linn. to have a paralyzing action on the central nervous system, due to erythrine, an alkaloid contained in the plant. Greshoff [3] also isolated erythrine from *E.* (*Stenotropis*) *berteroi* Hassk. and according to Plugge [4] this alkaloid is the active constituent of the plant. From the seeds of *E. hypaphorus* Boerl., Greshoff [5] and Van Romburg [6] obtained hypaphorine, an alkaloid which produces tetanus in frogs.[7] De

[1] This plant is also called *Erythrina indica* Lam. The botanical name adopted in this paper is in accord with the interpretation of Merrill in his classical work, An Interpretation of Rumphius' Herbarium Amboinense (1917) 276.

[2] Comptes rendus 92 (1881) 733.

[3] Meded. uit 's Lands Plant. 7 (1890) 29.

[4] Arch. f. exp. Path. u. Phar. 38 (1893) 46.

[5] Meded. uit 's Lands Plant. 25 (1898) 54.

[6] Proc. K. Akad. Weten. Amst. 13 (1911) 1177.

[7] Lewin, L., Traité de Toxicologie. Paris (1903) 646. (A translation from a German edition by G. Pouchet.)

la Loza and Altamirano isolated two toxic alkaloids, eritrocoraloidine and coraloidine, from *E. americana* Mill.,[8] a Mexican species commonly called "colorin." Other species of *Erythrina*[9] were also reported to contain alkaloids of unknown composition, one of them being the plant under investigation. Last April we obtained a supply of the seeds of *E. variegata* var. *orientalis* (Linn.) Merr. from plants growing in and around Manila. In view of the apparently incomplete data recorded in the literature it seemed desirable to investigate these seeds from the morphological and chemical viewpoints.

There are various medical properties attributed to *Erythrina variegata* var. *orientalis* (Linn.) Merr. In the Philippines, Tavera[10] states that this plant is used as a purgative and diuretic and that the bark and leaves possess febrifugal property. According to Dymock,[11] several writers reported different uses of this plant in India. Nothing definite, however, is known with regard to the physiological properties of the seeds of this plant.

MORPHOLOGICAL STUDY

Material and methods.—The seeds used in this study were soaked in water for about twenty-four hours to render the seed coats suitable for sectioning. Sections from 20 to 30 μ thick were cut with a slide microtome. Surface preparations of the seed coats and cotyledons were made free hand with the aid of a safety-razor blade. Some of the sections were examined in water, dilute glycerine, or chloral hydrate mount without staining, while the other sections were stained by means of safranin, contrasted with Delafield hæmatoxylin, and mounted in water or dilute glycerine.

For the study of the individual characteristics of the different types of cells, Schultz's maceration process as described by Greenish[12] was employed with certain modification. Sodium hydroxide, 1 or 2 per cent solution, was used for the isolation and investigation of the shape and characters of the parenchymatous tissue of the seed coats and embryo.

[8] Martinez, M., Las plantas mas utiles que existen en la republica Mexicana (1928) 113.

[9] Wehmer Co., Die Pflanzenstoffe 1 (1929) 572.

[10] Plantas Medicinales de Filipinas. Madrid (1892) 107.

[11] Pharmacographia Indica 1 (1889–90) 451–454.

[12] The Microscopical Examination of Foods and Drugs. 2d ed. (1910) 56–58.

The following reagents were used for the microchemical detection of the starch grains, protein granules, oil globules, and alkaloids:[13]

1. Dilute solution of iodine with potassium iodide.
2. Tincture of alkana.
3. Mayer's reagent.
4. Wagner's reagent.
5. Picric acid solution.
6. Gold chloride solution.
7. Ferric gold chloride solution.

The seed.—Dap-dap seed is an exalbuminous seed. It is kidney-shaped or sometimes nearly ellipsoidal and measures from 10 to 20 millimeters in length, 9 to 12 millimeters in width, and 8 to 10 millimeters in thickness. On the flat, or lateral, side it is reniform in outline and on the concave, or ventral, side and on the convex, or dorsal, side it is elliptical or oblong elliptic, except when there is a depression at the base where it becomes somewhat oblong ovate in outline (Plate 1, fig. 4). The base and the apex normally are rounded, but in some cases there is a concave depression at the base or at both the base and the apex (Plate 6, fig. 37). On the concave edge, or ventral side, there is a fairly large scar known as the hilum, which consists of a white or brown elliptical, boat-shaped or oblong ovate, smooth scar with a narrow groove along the middle from the upper to the lower end (Plate 1, fig. 5). On the convex, or dorsal, side there is also a narrow angular ridge extending from the apex to the base toward the raphe or the upper end of the hilum where it expands forming a heart-shaped, dark brownish red elevation, with a slight vertical depression or groove. The color of the seed varies from reddish brown to dark brownish red or dark chocolate color and its surface is smooth and shiny. The micropyle is found near the lower end of the hilum, consisting of a slight and minute depression. The seed coat is thin and somewhat hard or tough when dry, but pliable and elastic when moist. The embryo is large, consisting of two white, large, thick, and firm cotyledons, closely appressed and inclosing the epicotyl. The epicotyl is very small and bears two very minute immature leaves. The hypocotyl is also small and lies outside of the cotyledons and is bent backward along the

[13] The writers deeply appreciate the help rendered by Mr. José V. Santos, of the Department of Botany, University of the Philippines, in the preparation of the material and drawings.

line of meeting of the cotyledons on the concave, or ventral, side (Plate 1, figs. 6 and 7).

Microscopic structure.—The seed in transverse section is broadly ovate in outline. In the upper part of the broader side of the section there is a slight wavy depression with a very small slit at the middle region. This depression corresponds to the hilum, while the minute slit to the cross section of the tiny groove extends along the middle portion of the hilum toward the raphe. Apparently there is only one seed coat with varying thickness from 0.6 to 0.9 millimeter. It is thin toward the dorsal side and becomes progressively thicker toward the hilum. In the case of the pea, according to Smith,[14] there are two seed coats developed, respectively, from the two integuments; the inner seed coat is somewhat thicker and heavier than the outer, and the two are more or less firmly united. This may also be the case in the seed coats of the dap-dap, where the apparent single seed coat may consist of two coats derived from the two integuments which are firmly united. In view of the fact that this question cannot be settled without going into the study of the origin and development of the dap-dap seed coat or coats, no definite statement regarding the number of seed coats in the dap-dap seed can be given until a further morphological study is undertaken. This omission does not, however, affect the main purpose of this morphological work, which is simply to provide a description of the structure of the dap-dap seed that can be used as a basis for distinguishing it from other seeds. There are four more or less distinct regions of the seed coat or coats. The outermost region is the epidermis. It consists of radially elongated hyaline cells measuring from 0.25 to 0.30 millimeter in length and about 0.08 millimeter in diameter. Their cell walls are composed of cellulose traversed by pits and are strongly and irregularly thickened. The cavities of these epidermal cells are narrow toward the upper part and wide toward the base. At this part the lumen is usually irregular, wavy or jagged in outline. Plate 2, fig. 12, is a semidiagrammatic representation of a cross section through the seed coat or coats. In the surface view the epidermal cells are polygonal in outline, with very thick and pitted cell walls (Plate 2, fig. 13). The second or middle region is a wide parenchymatous region about 0.45 millimeter in thickness. To-

[14] A Textbook of General Botany, rev. ed. (1928) 437-8.

ward the outer part it is limited by the palisade epidermal cells and toward the inner side by greatly obliterated parenchyma cells. The parenchymatous region may be subdivided into two parts; namely, the hypoderma and the parenchyma. The hypoderma is composed of one or more layers of loosely arranged and radially elongated cells about 0.024 millimeter wide and 0.07 millimeter long. These cells are slightly constricted about the middle, and the upper end is wider than the lower end so that they simulate the shape of an inverted capstan. They are provided with numerous intercellular spaces and their walls are somewhat thick and not lignified. The parenchyma consists of ten to fifteen layers of thin- or thick-walled, radially elliptic or tangentially elongated cells. The two or three outer layers are radially elongated and those toward the inner side are elliptic or tangentially elongated. These cells are also supplied with intercellular spaces, and so are somewhat loosely arranged. They contain a reddish brown substance or pigment. The third region is relatively narrow. It is from 0.03 to 0.045 millimeter in thickness and is built up of a compact obliterated parenchyma. The fourth region, which is the innermost one, is about 0.15 millimeter in thickness. It also consists of several layers of tangentially obliterated parenchyma cells containing a reddish brown substance. In this region, however, the parenchyma cells are not so greatly compressed as those of the third region.

The structure of the section of the seed coat or coats at the region of the hilum is somewhat complicated. The epidermis consists of a double row of palisade cells, and in the outer part of this epidermis there are two or three layers of small radially or obliquely compressed cells with thin, white, and slightly suberized cell walls. The epidermis is interrupted at the middle part by a small slit, which represents the transverse section of the small narrow groove extended along the middle region of the hilum. Below this slit as illustrated on Plate 2, fig. 9, there is a flask-shaped group of lignified porous cells of polygonal, rectangular, or irregular outline. These porous cells are called tracheids by Greenish [15] and according to him their function is not accurately known. They are surrounded by three layers of elongated, thick-walled, somewhat flattened cells (Plate 2, fig. 12). At the inner part of the epidermis covering the

[15] The Microscopical Examination of Foods and Drugs. 2d ed. (1910) 234.

hilum there is a region of stone cells with slightly lignified thick and pitted walls. This region is bounded toward the inner part by an extensive group of thick-walled, pitted, and loosely arranged cells known as modified hypodermal cells. These cells have wavy or irregular outlines with large intercellular spaces filled with a brown substance. Their walls are not lignified. In the inner part the modified hypoderma is limited by obliterated parenchyma cells traversed by conducting tissue.

In the longitudinal section through the hilum the tracheid cells form an elongated region parallel to the epidermis and extending from near the micropyle to the raphe. Toward the micropyle this region is bounded by a group of short sclerenchyma cells or stone cells, at the other end by the raphe; in the inner part by the modified hypoderma and obliterated parenchyma cells, and toward the periphery by the epidermis. At the other side of the raphe, just below the epidermis corresponding to the elevated region, there is a group of slightly lignified stone cells, with thick and pitted walls. The micropyle appears as a small opening through the epidermis, bordered by short sclerenchyma cells and by loosely arranged, thick-walled, and irregularly shaped cells. The walls of these cells are not lignified and they are richly supplied with intercellular spaces.

The cotyledons in transverse section are plano-convex in outline. They are composed chiefly of thin-walled parenchyma cells filled with minute protein granules, oil globules, a very small amount of tiny starch grains, and some solitary or clustered monoclinic calcium oxalate crystals. The epidermis consists of small radially elongated parenchyma cells filled mostly with protein granules and some globules of fixed oils. In surface section these epidermal cells are polygonal in outline (Plate 1, fig. 14, and Plate 3, fig. 16). In the inner part of the epidermis there are one or two layers of radially elongated cells arranged somewhat in palisade form. These cells have thin walls and are filled like the epidermal cells with minute protein granules, a few starch grains, some globules of fixed oil, and occasionally with some calcium oxalate crystals. They are interspersed with small intercellular spaces. Plate 3, fig. 16, represents a segment prepared from the convex, or dorsal, side of a cotyledon, showing the epidermis and the palisade cells; fig. 17, on the same plate, shows a segment of a thin section through the middle portion of the cotyledon. This segment exhibits the characters of the parenchyma cells of the central region of the

cotyledon. They are polygonal in outline with slightly wavy cell walls and large intercellular spaces. These parenchyma cells like the palisade cells are richly supplied with protein granules, oil globules, and small starch grains in clusters of two, three, or four grains. Some calcium oxalate crystals are frequently found in the parenchyma cells of the middle region.

The seeds subjected to 2 per cent sodium hydroxide and Schultz's maceration process, respectively, exhibit the characteristic type of cells indicated on Plate 3, figs. 19 to 30. The palisade cells of the seed coat are observed singly or in groups; the peculiar capstan-shaped hypodermal cells are found here and there in various positions; the parenchyma cells from the seed coat are distinctly different from those of the cotyledons, because they possess an irregular outline and are somewhat flattened; the tracheid cells and stone cells display great diversity in shape and size. The tracheids are readily distinguished from the other cells because of their greatly perforated walls, while the stone cells are identified by their thick, lignified, and pitted cell walls. The cells from the modified hypoderma are also conspicuous. They also have thick and pitted walls, but not lignified. Their general appearance is very much like those of the stone cells. The epidermal cells of the cotyledon appear singly or in groups and are readily recognized from their size and elongated shape. They generally appear empty, but sometimes their content is preserved. The parenchyma cells from the middle region of the cotyledons are more or less rounded, usually empty, and with some slight protuberances bulging from the surface.

Starch grains.—The starch grains of the dap-dap seed are comparatively very small. They measure only about 0.005 millimeter in diameter. These starch grains are found either alone or in clusters of two, three, or four grains. They are ellipsoidal, elliptic, or ovate in outline, with very prominent, circular or elliptic hilum. On account of this prominent hilum the starch grains of the dap-dap appear very similar to the general outline of the red blood corpuscles of animals or man (Plate 3, figs. 18 and 19).

Protein granules.—The protein granules of the dap-dap seed are very small. They measure about 0.001 millimeter in diameter. Their structure is not very conspicuous. They are more or less rounded and in aggregated form.

Oil globules.—The oil globules are scattered throughout the cell cavities in the embryo, particularly in the cotyledons. They intermingle with the starch grains and protein granules. These globules are conspicuous even in unstained sections. They consist of minute globules ranging from 0.007 to 0.009 millimeter in diameter. When the sections are treated with freshly prepared alkana tincture they readily absorb the stain and become pinkish or reddish (Plate 3, fig. 19).

Crystals of calcium oxalate.—The cells of the cotyledons are frequently loaded with one or more calcium oxalate crystals in monoclinic or prismatic forms. These crystals are often found isolated or in clusters of two or more crystals. When they are in clusters of three or more crystals, they are often arranged in a more or less zigzag form. The individual crystal measures from 0.0065 to 0.011 millimeter in diameter and from 0.018 to 0.04 millimeter in length. They are especially abundant in the middle region of the cotyledons, but are absent from the seed coats (Plate 3, figs. 16 and 25).

Microchemical tests and localization of the alkaloid.—This brief microchemical investigation was undertaken as a supplement to the above study in order to determine the distribution of the alkaloid in the seed. The seed coats and the different regions or parts of the embryo were examined. Free-hand and microtome sections were prepared and treated with the reagents indicated above. The reagents were applied to the sections either directly or indirectly. The direct application of the reagent consists of first mounting the section in a very small amount of water and then treating with the reagent. In the indirect method the sections were first macerated for about twelve hours with a very dilute aqueous solution of hydrochloric acid before adding the reagents. Observations were made at short intervals for a period of an hour and after keeping the sections in a Frigidaire overnight. Rapid reactions with the alkaloidal reagents were obtained by heating the slides slightly on top of a paraffin oven for a couple of minutes. The tests were repeated several times until definite results were obtained. The results obtained from the tests of the sections supposed to contain alkaloid were compared with the results of the tests made on the sections freed from alkaloid, and from the results obtained by using a dilute acidulated solution of the pure alkaloid. The precipitates produced by the different reagents applied to the sections containing alkaloid are very similar to those formed when the dilute acidulated solution of

the pure isolated alkaloid was treated with the same reagents. The precipitates produced on the sections treated with picric acid, ferric gold chloride, and Wagner's reagents were rather slight and not very conspicuous, but those formed by the action of the same reagents on the dilute acidulated solution of isolated alkaloid were more pronounced and of granular or amorphous character. The most effective of the reagents employed in these experiments were the gold chloride solution and Mayer's reagent. In both tests a rapid reaction and a larger amount of precipitate were observed. However, the precipitate produced by the gold chloride is more conspicuous and characteristic, for it is granular and curdy and of a pinkish or purplish color at the beginning, gradually becoming black (Plate 3, fig. 31). The precipitate produced by Mayer's reagent was similar to those of the other reagents, but more copious and, moreover, the individual granules were larger.

From the results of these tests it appeared that the alkaloid is present in the different parts of the embryo, particularly in the cotyledon, and absent in the seed coats.

CHEMICAL STUDY

Preparation of the material.—The mature seeds were ground to a moderately coarse powder, and aliquot portions were used for the different determinations. In order to express the analytical data on a moisture-free basis, two portions of the powdered seeds were heated in an oven at 100° C. to constant weight and the percentage of moisture determined in the usual manner.

Preliminary analysis.—A sample (10 grams) was boiled with 95 per cent alcohol (reflux) and the alcoholic filtrate was evaporated on a water bath. A portion of the residual extract was treated with acidified water and the acid solution tested with the usual alkaloidal reagents, whereupon copious precipitates were noted. The remaining extract was first treated with ether and then with water. It was found that the alkaloid is soluble in water, but insoluble in ether.

Another 10-gram sample of powdered seeds was boiled with 25 per cent alcohol and filtered. The filtrate was concentrated and tested for the presence of saponaceous glucosides with the following results:

(*a*) When treated with emulsin, or hydrolyzed with hydrochloric acid and then neutralized with carbonate, it reduced Fehling's solution.

(*b*) It gave a blood red color with concentrated sulphuric acid.

(*c*) It produced a Turnbull's blue color with an aqueous solution of potassium ferricyanide containing ferric chloride.

(*d*) It emulsified a fixed oil.

(*e*) It formed precipitates with lead acetate and barium hydroxide solutions.

Guignard's test [16] for the detection of cyanophoric glucosides applied to a 5-gram sample gave a negative result.

A portion (10 grams) of the sample was extracted successively in a Soxhlet apparatus with various solvents, and the following amounts of residue, dried at 100° C., were obtained:

Extract.	Per cent.
Ether	15.91
Petroleum ether	0.60
Chloroform	1.07
Ethyl acetate	1.31
Ethyl alcohol	4.38
Total	23.27

The ether extract was found to consist mostly of oil, while the alcoholic extract was syrupy and contained the alkaloid. The other extracts were too small for further examination.

Proximate chemical analysis.—This was determined according to the method proposed by Waksman and Stevens [17] and the result obtained is shown in Table 1.

TABLE 1.—*Proximate chemical composition of dap-dap seeds.*

Constituent.	Per cent.[a]
Ether-soluble portion	15.91
Alcohol-soluble portion	0.54
Cold-water soluble organic matter	21.07
Hot-water soluble organic matter	3.42
Hemicelluloses	13.74
Celluloses	20.37
Lignin	14.63
Crude protein	1.01
Ash	5.01
Total	95.70

[a] Calculated on moisture-free basis.

[16] Haas, P., and T. G. Hill, An Introduction to the Chemistry of Plant Products 1 (1921) 17.

[17] Ind. Eng. Chem. Analytical Ed. 2 (1930) 167.

Isolation of the alkaloid.—For the separation of the alkaloid from dap-dap seeds, several methods were tried. Since the alkaloid easily forms crystalline salts with either hydrochloric acid or hydrobromic acid, attempts were first made to separate the free alkaloid in the form of its salt and then regenerate it by dissolving the alkaloidal salt in water, adding to the solution an excess of sodium carbonate, drying the mixture on the water bath, and extracting the alkaloid with absolute alcohol. It was found that the alkaloid obtained in this manner is always contaminated with traces of sodium salts.

The methods for the preparation of hypaphorine,[18] as given by Greshoff, from *Erythrina hypaphorus* Boerl. were next tried, but these also failed to give satisfactory results. The procedure finally adopted consisted in precipitating the alkaloid from its aqueous solution with phosphomolybdic acid (Sonnenchein's reagent), mixing the precipitate with sodium carbonate, and after drying the mixture, extracting the liberated alkaloid with absolute alcohol. For this purpose, one kilogram of the ground seeds was first extracted repeatedly with ether in order to remove the oil. The combined ethereal extracts were distilled and the oil reserved for further analysis. The powdered seeds from the ether extraction were allowed to dry at room temperature and percolated with ordinary alcohol. The percolate was subjected to distillation under reduced pressure, and the alcohol was completely removed by heating the concentrated solution on the water bath. The syrupy extract obtained was dissolved in water and filtered. Phosphomolybdic acid solution was then added to the aqueous liquid until no further precipitate was formed. The precipitate was collected, washed with water containing a little of the phosphomolybdic acid solution, and the moist precipitate was mixed with sodium carbonate and then dried on a water bath. The mixture was then treated repeatedly with absolute alcohol, boiled (reflux), and filtered. The combined alcoholic filtrate was concentrated by distillation and the alkaloid allowed to crystallize. For the purification of the impure alkaloid the colored crystals were redissolved in absolute alcohol, a small amount of animal charcoal added, and the solution filtered. Upon evaporating the filtrate, white crys-

[18] The writers desire to express their thanks to Dr. Otto Schöbl, of the Bureau of Science, for his kindness in translating from Dutch into English the directions for the preparation of hypaphorine as given in Meded. uit 's Lands Plant. 25 (1898) 56.

tals of the alkaloid were obtained. Photomicrographs of the alkaloid, as well as its salts, crystallized from different solvents, are shown in Plates 4 to 6, figs. 32 to 36. The free alkaloid is very soluble in water, fairly soluble in ethyl and methyl alcohols, but insoluble in ether and petroleum ether. The alkaloid reduces potassium permanganate and ferric chloride at low temperature and gives an intense violet coloration on the addition of glyoxylic and sulphuric acids. When heated with aqueous potassium hydroxide, the fishy odor of trimethyl amine was noted. It begins to melt at 238° C., changing into a brown substance, thereby obscuring the exact melting point. In general, these properties are those of hypaphorine,[19] which was isolated by Greshoff [20] from *Erythrina hypaphorus* Boerl. The identity of this alkaloid was further confirmed by the result of the elementary microanalysis of the anhydrous alkaloid.[21]

TABLE 2.—*Elementary microanalysis of the anhydrous alkaloid.*

	Carbon.	Hydrogen.	Nitrogen.
	Per cent.	*Per cent.*	*Per cent.*
Calculated for $C_{14}H_{18}N_2O_2$ (hypaphorine)	68.24	7.38	11.37
Found:			
Analysis I	68.30	7.30	11.40
Analysis II	67.90	7.76	11.40

Physiological effect of the alkaloid.—An aqueous solution of the alkaloid isolated, when injected subcutaneously into a guinea pig at intervals and in varying doses up to 0.1 gram of the substance, did not produce any apparent toxic symptom. According to Plugge,[22] hypaphorine is physiologically a very peculiar substance. From several tests made by him, using rabbits, cavies, mice, pigeons, frogs, and fishes, the substance was found poisonous only to the frog. In this amphibian, he observed that different doses of this alkaloid up to 5 milligrams produced only symptoms of excitation, but when the amount was increased from 12 to 75 milligrams, a still higher excitability and finally a strong tetanus was noticed two and one-half to twenty-four

[19] Van Romburgh, P., and G. Barger, Trans. Chem. Soc. 99 (1911) 2068.

[20] Loc. cit.

[21] The writers are indebted to Dr. Alfredo Santos, of the School of Pharmacy, University of the Philippines, for the microanalysis of the alkaloid.

[22] Tijdschr. v. Geneesk. 1 (1893) 933. From Meded. uit 's Lands Plant. 25 (1898) 61.

hours after administration. In the case of the rabbit, he found that a considerable amount of hypaphorine injected subcutaneously was eliminated as such in the urine.

The hydrochloride and hydrobromide salts of the alkaloid are colorless with melting points of 227° C. and 225° C., respectively. The hydrochloride salt occurs in clusters of featherlike crystals and the hydrobromide in radiating needlelike crystals. They also reduced potassium permanganate and ferric chloride solutions at low temperatures.

Quantitative estimation of the alkaloid.—A sample consisting of 50 grams of the air-dried, ground seeds was treated with ether and then with ordinary alcohol in the same manner as in the extraction of the alkaloid already described, and from the alcoholic extract the alkaloid was removed in the form of its hydrobromide salt. There was obtained an amount of hydrobromide (1.5005 grams) corresponding to 2.505 per cent of the free alkaloid computed from the moisture-free sample.

The fatty oil.—The viscous yellow oil of dap-dap seed, obtained by extraction with ether, has a peculiar and characteristic odor and was found to give the following physical constants:

Specific gravity at 30° C.	0.9071
Refractive index at 30° C.	1.4625
Saponification number	240.12
Iodine number	25.37
Acetyl value	13.02

Isolation of the saponin.—After treatment with 95 per cent alcohol to separate the alkaloid, the powdered residue was heated moderately with a sufficient amount of water and the resulting mixture was strained through muslin. The brown liquid was set aside overnight to allow the fine particles of powder to settle out. The clear aqueous liquid was then decanted and filtered. The filtrate was precipitated by basic lead acetate and the precipitate collected and washed well with water. It was then suspended in water and decomposed by means of hydrogen sulphide. The lead sulphide precipitate was removed by filtration, and bubbles of air were passed through the aqueous filtrate to remove the excess hydrogen sulphide. The liquid was then evaporated to drynes in a vacuum oven, dissolved in methyl alcohol, and the solution filtered. This alcoholic solution was concentrated to a small volume, precipitated with ether, and the ether-alcohol mixture allowed to stand over the saponin for twenty-four hours to allow any resinous substances, carried down by

the precipitated saponin, to redissolve. A brown precipitate was produced which was filtered and dried in vacuum. The product obtained gave positive results with the usual tests for saponin.

SUMMARY

The dap-dap seed is exalbuminous, and kidney shaped with a fairly large elliptical or oblong-ovate hilum at the concave side. The surface is smooth and shiny and of a reddish brown to dark chocolate color.

The seed coat or coats consist of (*a*) radially elongated epidermal cells arranged in the form of palisade, (*b*) hypoderma, (*c*) middle parenchyma, (*d*) greatly obliterated parenchyma, and (*e*) inner obliterated parenchyma.

The transverse section through the hilum is characterized by (*a*) a slit leading to the group of flask-shaped tracheid cells, (*b*) radially or obliquely elongated or flattened, slightly suberized parenchyma cells, (*c*) double rows of palisade epidermal cells, (*d*) a region of short sclerenchyma cells, (*e*) modified hypoderma, and (*f*) obliterated parenchyma.

In the longitudinal section through the hilum the following may be noted: (*a*) Raphe, (*b*) micropyle, (*c*) double rows of palisade epidermal cells, (*d*) stone cells, (*e*) modified hypoderma, and (*f*) tracheids.

The embryo is large and consists of two thick kidney-shaped cotyledons, the epicotyl, which bears two minute immature leaves, and the hypocotyl.

The cotyledons in transverse section are characterized by (*a*) the small radially elongated epidermal cells heavily loaded with protein granules and a few oil globules; (*b*) large intercellular spaces, palisade and parenchyma cells richly supplied with protein granules, oil globules, monoclinic calcium oxalate crystals, and minute rounded or ellipsoidal starch grains with large circular hilum.

The alkaloid of dap-dap seed is located in the embryo, especially in the cotyledons. Gold chloride solution produces characteristic granular and curdy precipitate with this alkaloid, while Mayer's reagent gives an amorphous noncrystalline precipitate.

The proximate chemical composition of the seed and the amounts of extracts from various solvents were determined.

The important plant constituents obtained from the seed are, an alkaloid, a fatty oil, and a saponaceous glucoside.

The alkaloid isolated from the seed occurs in colorless crystals and has reducing properties. It also responds to the Hopkins-Cole reaction for the presence of the tryptophane group. From the result of the elementary analysis and from its properties, the alkaloid is identical with hypaphorine ($C_{14}H_{18}N_2O_2$), which was obtained by Gresshoff from *Erythrina hypaphorus* Boerl.

The alkaloid easily forms crystalline, colorless salts with hydrochloride and hydrobromic acids. The hydrochloride is obtained in a cluster of featherlike crystals, and the hydrobromide in radiating needlelike crystals. These salts have also reducing properties.

Computed on a moisture-free basis, the seed contains 15.91 per cent of fixed oil and 2.504 per cent of the alkaloid.

The fatty oil of the seed is a yellow, viscous liquid and has a peculiar and characteristic odor. Some of the physical constants of the oil were determined.

No apparent toxic symptom was observed in a guinea pig when varying doses of the aqueous solution of the alkaloid were injected subcutaneously.

A convenient method was found for separating saponin from the seed.

ILLUSTRATIONS

[All of the plates illustrate *Erythrina variegata* var. *orientalis* (Linn.) Merr. All microscopic drawings were traced by Mr. J. V. Santos under the direction of the authors; figures 1 to 3 by Mr. R. Aguilar; figure 2 traced from volume 1, plate 217, of the Flora de Filipinas by Blanco, and figures 4 to 7 by W. García.]

PLATE 1

FIG. 1. A habit sketch of the terminal portion of the branch showing the character and arrangement of leaves; × 0.4.

2. An inflorescence showing the general features of the flowers; × 0.4.

3. A single mature fruit. × 0.4.

4. A lateral view of a seed, *hi*, hilum; × 1.5.

5. Ventral view of a seed showing *hi*, hilum; *m*, micropyle; × 1.5.

6. A median longitudinal section through the hilum passing between the cotyledons; *hi*, hilum; *hy*, hypocotyl; *ep*, epicotyl; *c*, cotyledon; *sco*, seed coats; × 1.5.

7. A transverse section of the seed through the hilum; *hi*, hilum; *sco*, seed coats; × 1.5.

8. A diagrammatic sketch of a longitudinal section through the hilum of the seed coats; *e*, epidermis; *tr*, tracheids; *ra*, raphe; *mhd*, modified hypoderma; *m*, micropyle; *sc*, stone cells; *hp*, hypoderma; p^1 and p^2, obliterated parenchyma; *v*, vessels; × 7.

PLATE 2

FIG. 9. A diagrammatic sketch of a transverse section of the seed coats through the hilum; *e*, epidermis; *sp*, suberized parenchyma; *sc*, stone cells; *p*, parenchyma; *tr*, tracheids; *op*, obliterated parenchyma; × 24.

10. A detailed drawing of a small segment from a transverse section through the hilum showing, *mhd*, modified hypoderma; *op*, obliterated parenchyma; *tr*, tracheid; × 450.

11. A portion of a transverse section through the outer region of the seed coat of the hilum; *sp*, suberized parenchyma; *e*, epidermis, *sc*, stone cells; × 165.

12. A semidiagrammatic transverse section of the seed coat from the lateral side of the seed; *ep*, epidermis; *hd*, hypoderma; *p*, parenchyma; op^1 and op^2, obliterated parenchyma; × 55.

13. A small portion of a surface view of the epidermis showing the character of the epidermal cells; × 450.

14. A surface view of a segment of the epidermis of the cotyledon; × 450.

15. A detailed drawing of a segment of the transverse section through the epidermis and hypoderma; *cu*, cuticle; *e*, epidermal cells; *hd*, hypoderma; *is*, intercellular space; × 210.

PLATE 3

FIG. 16. A detailed drawing of a segment of the transverse section through the peripheral part of a cotyledon; *e*, epidermis; *pal*, palisade; *co*, calcium oxalate crystals; × 450.

17. A portion of a transverse section of the cotyledon taken from the middle region; *is*, intercellular space; × 210.
18. A group of starch grains highly magnified; × 700.
19. A parenchyma cell from a transverse section of a cotyledon highly magnified; *og*, oil globules; *sg*, starch grain; *pg*, protein granules; × 700.
20. A group of isolated hypodermal cells; × 210.
21. A group of isolated epidermal cells; × 210.
22. Another group of hypodermal cells drawn from the macerated section of the seed coat by a solution of sodium hydroxide; × 210.
23. A group of isolated stone cells from the seed coat near the hilum; × 210.
24. A group of modified hypodermal cells or parenchyma with thick and not lignified cell walls; × 210.
25. A group of isolated calcium oxalate crystals; × 450.
26. A group of parenchyma cells from the seed coat; × 210.
27. Another group of parenchyma cells from the seed coat isolated by the application of sodium hydroxide maceration process; × 210.
28. Isolated tracheid cells showing their greatly perforated cell walls; × 210.
29. Isolated epidermal cells of the cotyledon; × 210.
30. Parenchyma cells from the macerated section of the cotyledon by sodium hydroxide solution; × 210.
31. A parenchyma cell from the transverse section of the cotyledon with alkaloidal precipitate of gold chloride; × 450.

PLATE 4

FIG. 32. Featherlike crystals of the alkaloid hydrochloride.

33. Radiating needlelike crystals of the alkaloid hydrobromide.

PLATE 5

FIG. 34. Crystals of the alkaloid obtained by slow crystallization from methyl alcohol solution.

35. Alkaloid crystals from ethyl alcohol solution.

PLATE 6

FIG. 36. Crystals of the alkaloid obtained by slow evaporation of an aqueous solution on a microscopic slide.

37. A photograph of a group of seeds.

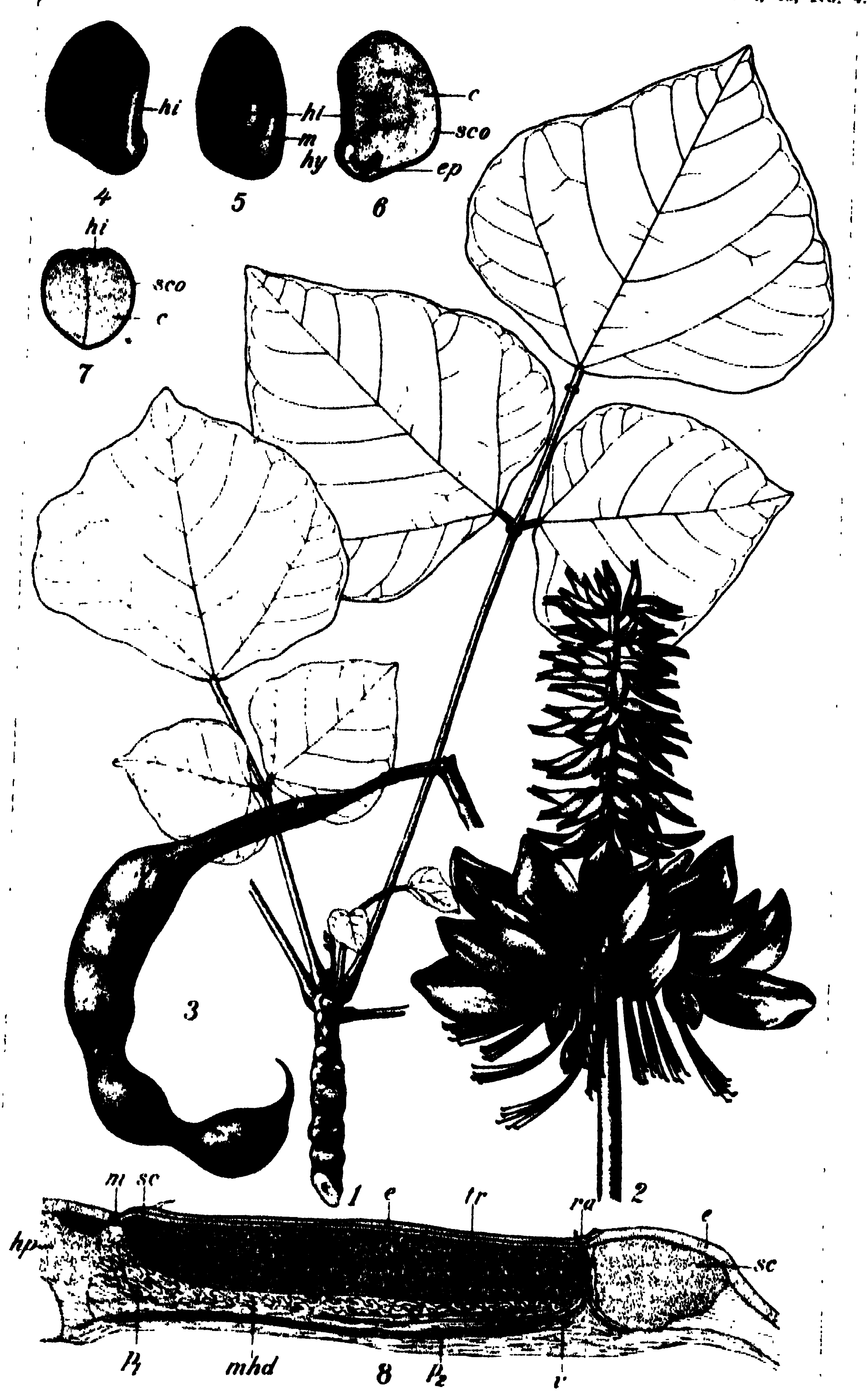

PLATE 1.

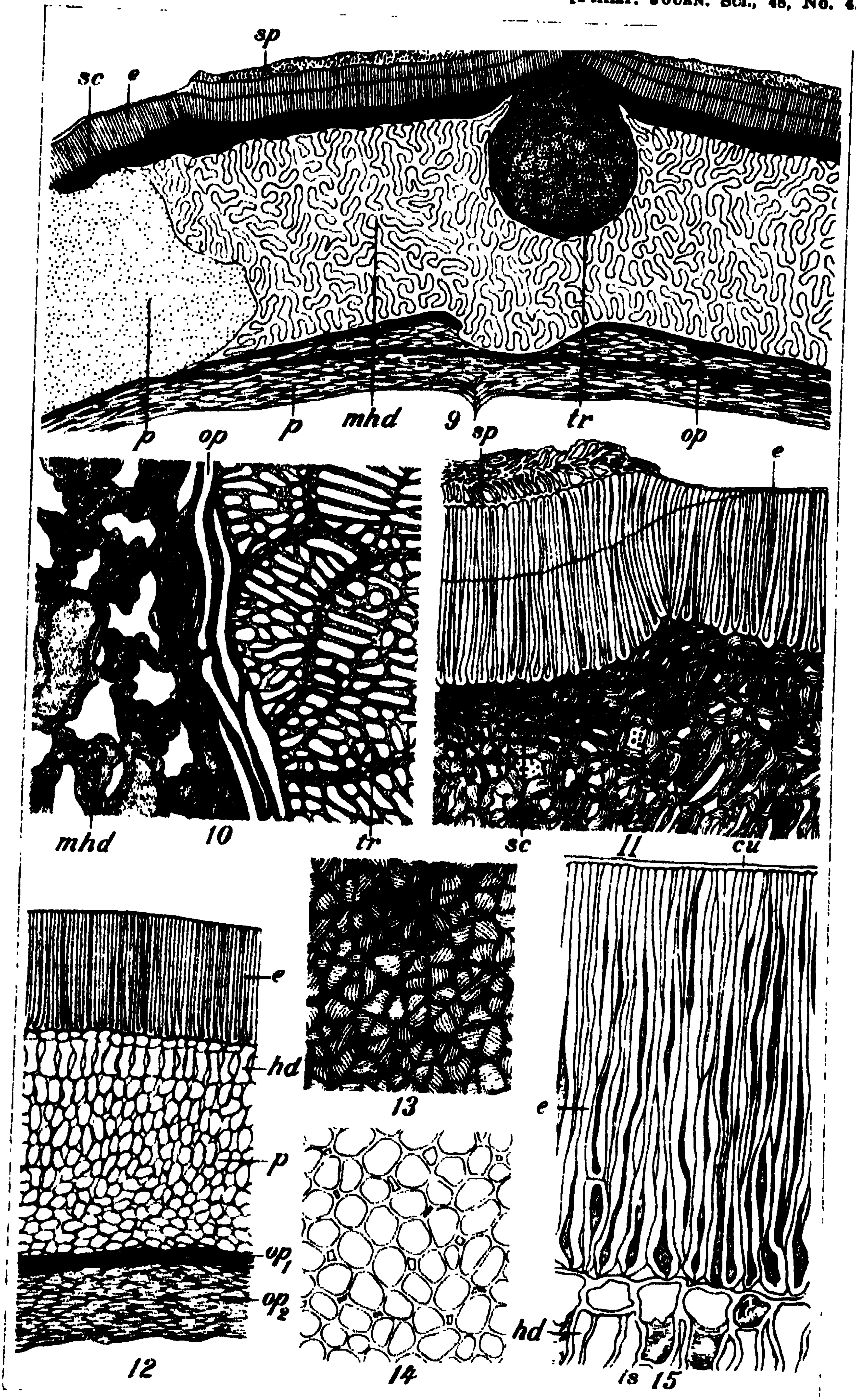
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PLATE 2.

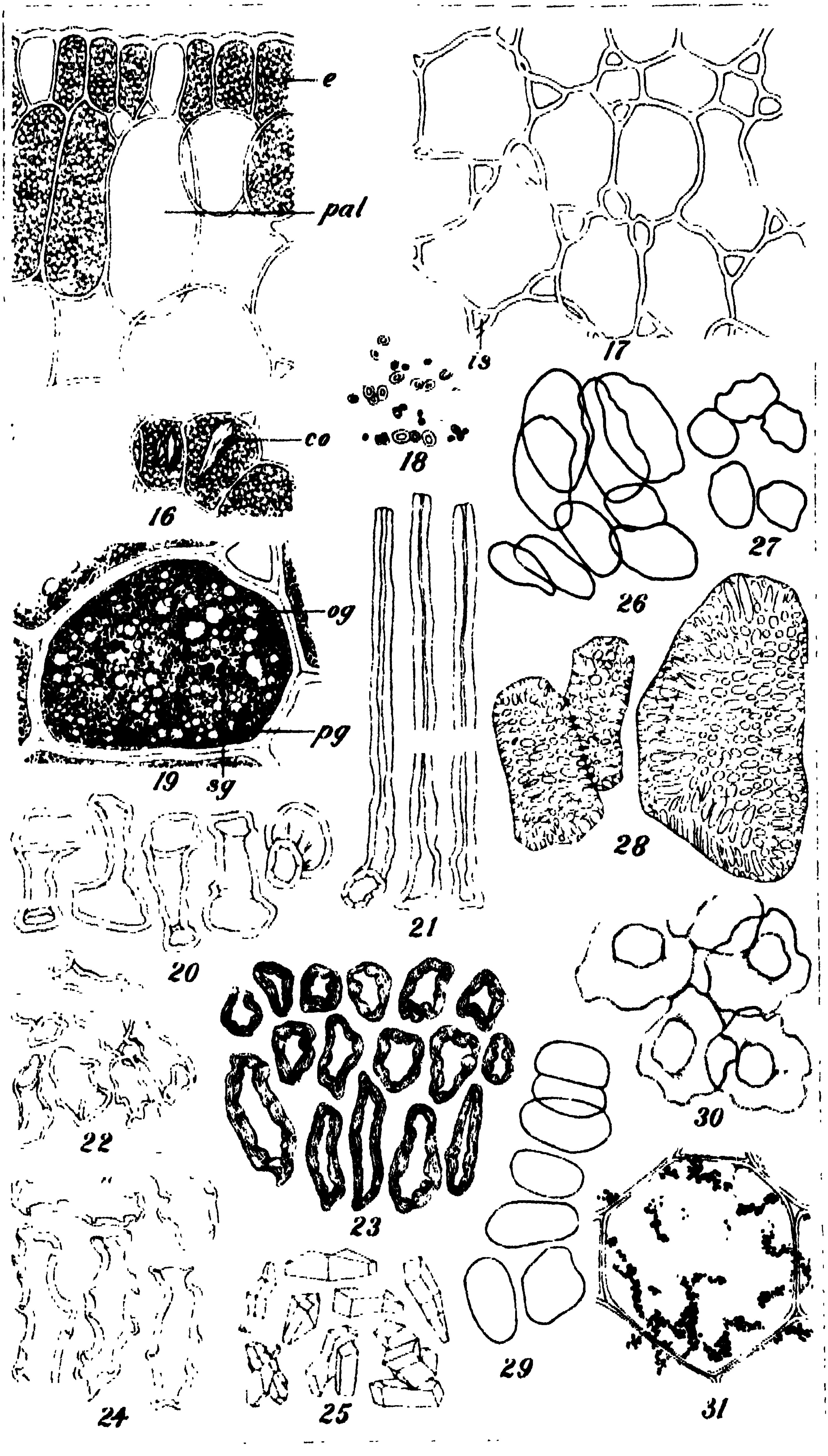

PLATE 3.

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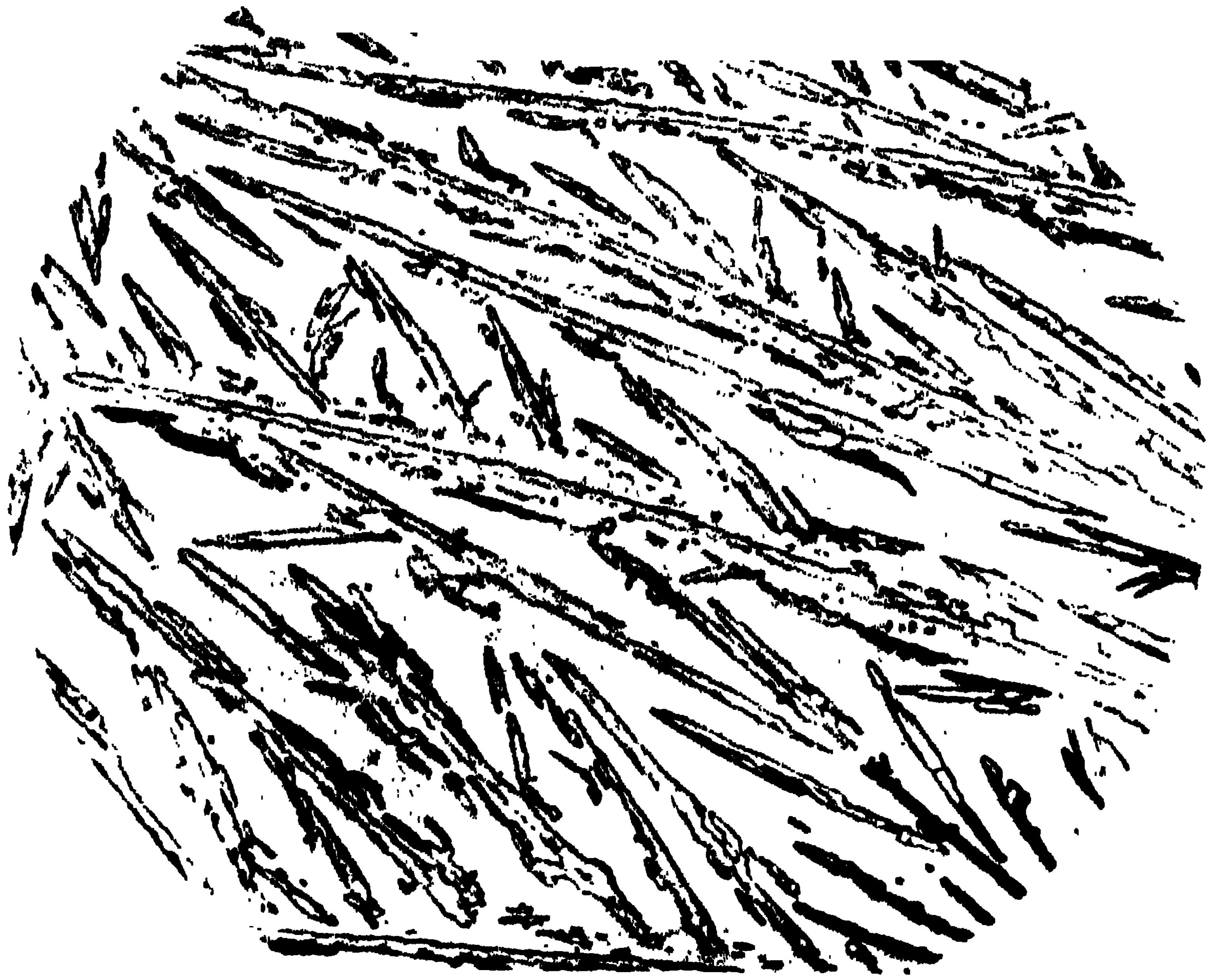
PLATE 4.



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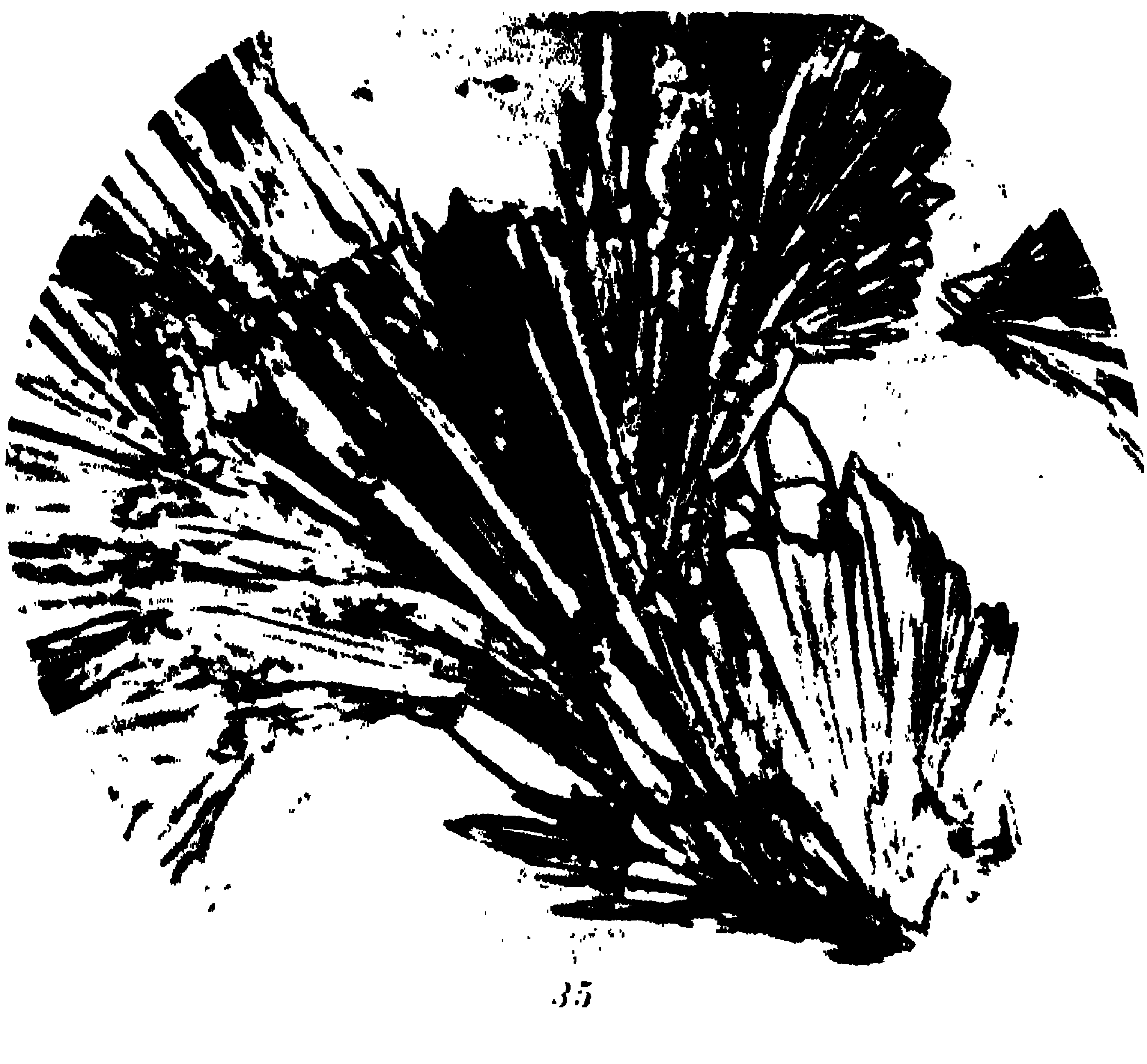

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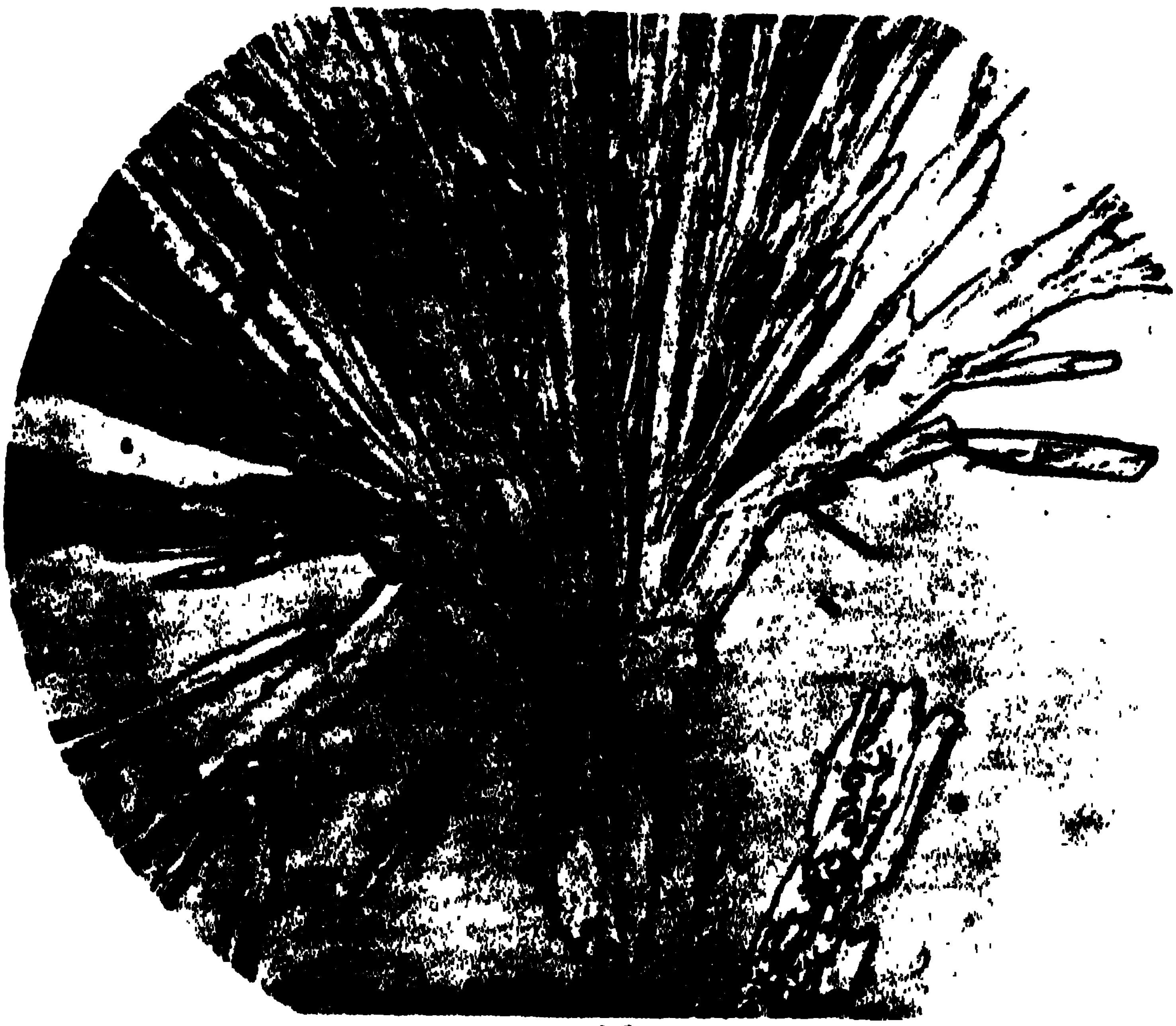
PLATE 5.



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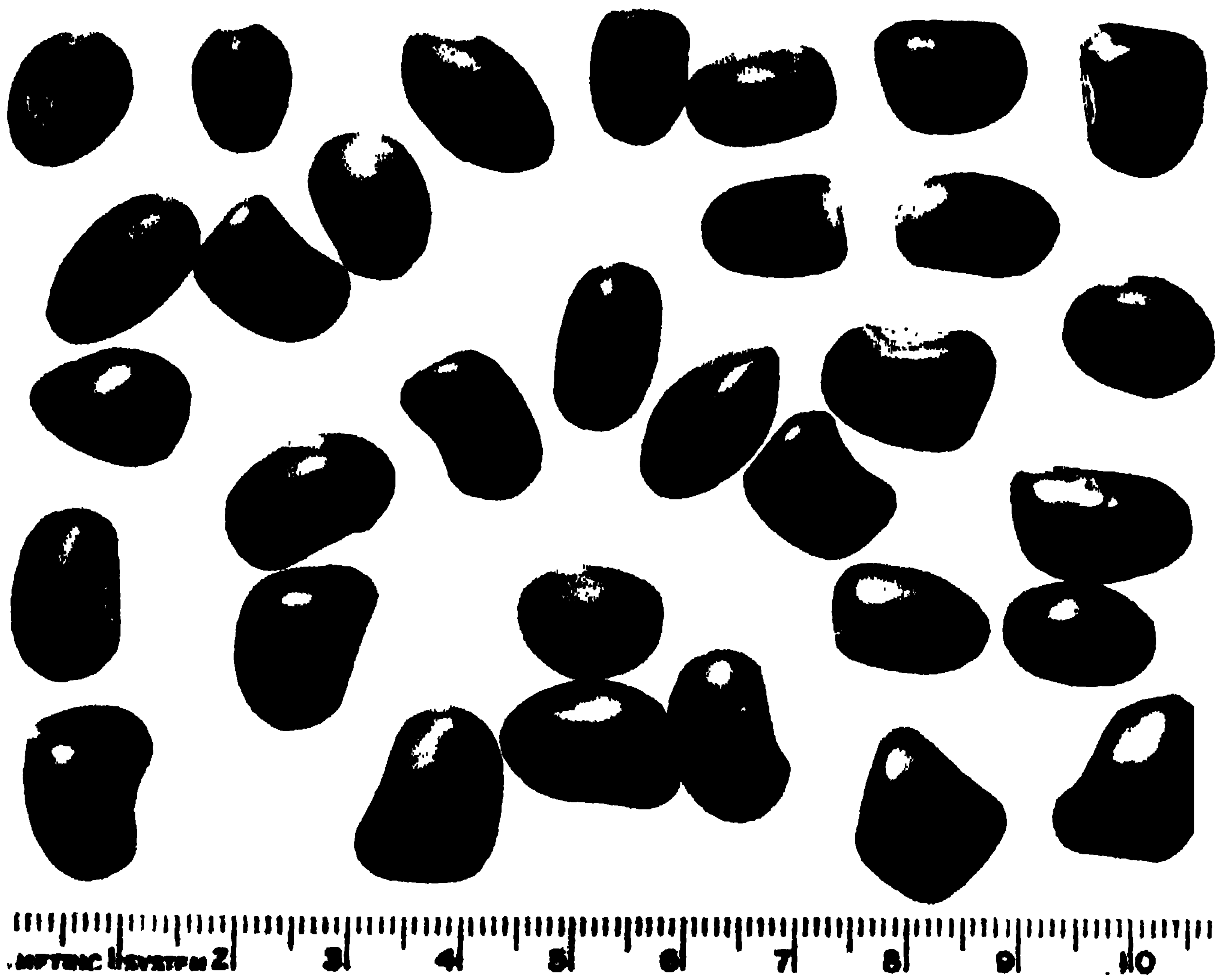

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PLATE 6.

OBSIDIANITES IN THE PHILIPPINE ISLANDS [1]

By T. HODGE-SMITH

Contribution from the Australian Museum, Sydney

TWO PLATES

Mr. F. W. McCaw, of Manila, Philippine Islands, presented thirteen examples of these interesting objects to the Australian Museum, Sydney, New South Wales, Australia, with a request that an examination be carried out, and a comparison made with the australite variety of obsidianite. Mr. McCaw kindly lent three large specimens to assist in such an investigation, and these notes are placed on record in accordance with his request.

The sixteen specimens all come from the Sitio of Pugad Baboy, Municipality of Polo, Bulacan Province, Philippine Islands. According to the Rev. Miguel Selga, S. J.,[2] these objects were first discovered by Prof. H. Otley Beyer near the town of Novaliches in 1926. They have been recorded from Rizal, Nueva Ecija, and Batangas Provinces, so that the stones described here are from a new locality.[3]

The form of the stones varies considerably, and among the specimens examined there appear to be three distinct types; namely, spheroid, cylindrical, and irregular.

The spheroid type.—The larger stones appear to be wholly of this type, and the largest diameter measured is 4.9 centimeters. They are characterized by a more or less pitted surface, doubtless caused by escaping gases and vapors during cooling. Often the surface is segmented by a number of curved crevasses, which do not represent shrinkage cracks such as are found in

[1] Submitted by F. W. McCaw, superintendent of artesian wells, Philippine Bureau of Public Works.

[2] Meteorites in the Philippines, Pub. Manila Observatory No. 9 (1930) 24–26.

[3] One specimen, Bureau of Science Museum No. 3886, was collected in Busuanga Island, by Mariano P. Maat. Rev. M. Selga, director of the Weather Bureau, submitted another specimen of the "spheroid type" and reported that it was collected from the Barrio of Lawaan, Wright, Samar.—V. ELICAÑO.

quenched glass. The crevasses are not V-shaped but U-shaped, the deeper ones more nearly approaching the typical V-shape, but, nevertheless, having a slightly flattened or rounded base. They are obviously not formed after consolidation of the glass, and it is difficult to see how they could be formed by surface fusion such as stony meteorites often exhibit. If this is so, they must have formed before consolidation. It is well known that lava pools in volcanic craters are often coated with a somewhat plastic skin. It seems reasonable to assume that while still in a state of fusion these stones would become covered with a plastic skin or coating in the earlier stages of cooling. The pitted nature of the outside surface shows that a considerable amount of volatile matter is lost before consolidation. This, together with cooling, connotes a fairly large amount of shrinkage before the glass actually sets. Differences in density and perhaps elasticity of the surface coating would lead to the formation of crevasses where the coating offered least resistance to shrinkage. The surface of the crevasses always has a much better luster than the rest of the outer surface of the stones, but this may be due to greater protection from abrasion subsequent to falling. It is to be remembered that they have been found in alluvium, and are considered at least prehistoric. Sometimes the crevasses are more or less circular, forming an "island" which has a most striking resemblance to some forms of australites. The convex upper surface, the thin flange, and the facetted sides are preserved more or less perfectly in these "islands." Should the crevassing proceed to the ultimate breaking up of the stone it would result in the production of a number of australites. Mr. G. C. Clutton, of the preparatorial staff of the Australian Museum, made a cast of one of these islands; trimming the base to the bottom of the crevasse, and painting the cast black, he produced a perfect australite.

The discovery of these stones, while not disproving the "Bubble Theory" as propounded by E. J. Dunn,[4] makes it quite clear that any form of the australites, even the dumb-bell type, can be produced without the aid of a bubble.

Unfortunately, only one billitonite is available to me, but an examination of that one reveals a remarkable similarity to the spheroid type, particularly in regard to the surface crevasses.

The cylindrical type.—This is represented by one specimen

[4] Geol. Survey Victoria Bull. 27 (1912).

only, which has some slight resemblance to the poorer specimens of the dumb-bell variety of australite.

The irregular type.—This type of stone appears to be always small, and owes its irregularity to a particularly vesicular surface. These stones in no way resemble the moldavites in their irregularity of form, neither are they comparable to any australites known to me.

The color of the Philippine stones is jet black by reflected light, and olive brown by transmitted light through thin chips. In regard to color they are, therefore, comparable to both the billitonites and australites, but differ from the moldavites.

Thin sections under the microscope are seen to be completely isotropic without any indication of crystallization or structure. There appears to be a complete absence of gas bubbles in the interior.

The specific gravity of five stones was measured, giving a variation of from 2.441 to 2.448, with an average of 2.444, pointing to a remarkable uniformity in their composition. According to Summers [5] the specific gravity of the australites varies from 2.376 to 2.49. F. E. Suess [6] gives a list of specific gravity values for all obsidianites, and from this list it will be seen that the billitonites vary from 2.443 to 2.503, and the moldavites from 2.318 to 2.385. Obviously it is not possible to differentiate, by means of specific gravity determinations, between australites, billitonites, and the Philippine Islands stones, though all three are distinct from the moldavites.

A chemical analysis of one of the stones was carried out by Mr. H. P. White, formerly chief analyst to the Department of Mines, New South Wales. The result of his work is given, together with an analysis of an australite and of a billitonite, for comparison.

There is a very marked similarity between the chemical composition of the Philippine stone and that of the australite from near Coolgardie, Western Australia. There is almost as close an agreement with the billitonite from Dedang, the only difference being a somewhat higher sodic content in the billitonite. All three stones belong to the subrang Almerose of the C. I. P. W. classification.[7] Incidentally, it has been pointed out by

[5] Obsidianites—their origin from a chemical standpoint, Proc. Roy. Soc. Victoria 21 (1909) 423–443.

[6] Die Herkunft der Moldavite und verwandter Gläser, Jahrb. d. k. k. geol. Reichsanst, Vienna 50 (1900) 242–244.

[7] U. S. Geol. Surv. Prof. Paper 14 (1903).

Analyses of obsidianite, australite, and billitonite.

	I. Obsidianite, Bulacan Province, Philippine Islands, H. P. White, analyst.	II. Australite, near Coolgardie, Western Australia.[a]	III. Billitonite, Tebrung, Dendang; C. V. John, analyst.
SiO_2	70.88	70.62	70.92
Al_2O_3	12.38	13.48	12.20
Fe_2O_3	1.20	0.85	1.07
FeO	4.32	4.44	5.42
MgO	2.62	2.42	2.61
CaO	3.97	3.09	3.78
MnO	Trace.	0.42	0.14
Na_2O	1.61	1.27	2.46
K_2O	2.39	2.22	2.49
TiO_2	0.86	0.90	
Loss on ignition	0.18	0.07	
	100.36	99.75	1[illegible]

[a] Traces of nickel and cobalt.

Norm for analysis I.

Quartz		37.68
Orthoclase	13.90	
Albite	13.62	
Anorthite	19.46	
Feldspar		46.98
$MgSiO_3$	6.50	
$FeSiO_3$	5.54	
Enstatite		12.04
Ilmenite		1.52
Magnetite		1.86
		100.08

Classification: II, 3, 3, 3, ALMEROSE.

Summers[8] that Washington has included only one analysis of a terrestrial rock under this subrang.

From the above facts it will be seen that there is a very close relationship between the billitonites and the obsidianites from the Philippine Islands. It would be a difficult matter, if not impossible, to separate the two in a mixed collection. Chemically the latter appear to be more closely related to the australites in one respect only, that is in the soda content. In view of the fact that there are only three available analyses of billitonites made before the beginning of this century and only one of the

[8] Loc. cit. p. 430.

Philippine Islands stone, it cannot be stated definitely that this constitutes a fundamental difference.

In 1909 J. B. Scrivenor [9] gave the following localities in which billitonites had been discovered: Billiton; Mount Moeriah, Djapara, Java; Pleiari, Tanah Laut, Southeast Borneo; Sungri Riam, Tanah Laut, Southeast Borneo; Bungaran (Natuna Archipelago); Blat and Gambang Valleys, Pahang; Gemas and Sungri Triang, Negri Sembilan; Sudu Seremban, Negri Sembilan.

In view of this distribution of the billitonites, it is not unreasonable to extend the area to the Philippine Islands. Further support for such an extension is to be found in their mode of occurrence. At Pahang the billitonites are found in the tin-bearing alluvium, and in the Philippine Islands I am informed that they also occur in detrital deposits.

Considering all the available evidence I have no hesitation in including the Philippine Islands obsidianites with the billitonites. I can see no justification for the new name, rizalite, as proposed by Professor Beyer and recorded by Rev. Miguel Selga.[10] It is not proposed to discuss the origin of obsidianites here, but if the meteoric origin be accepted, as it is by Rev. Miguel Selga and myself, then it would seem that a new name is not only unnecessary but undesirable.

Since making the above notes, Mr. McCaw has sent me a photograph of a type of billitonite from the Philippine Islands which differs from those already described. I suggest that this type should be called the "drop" type.

[9] Obsidianites in the Malay Peninsula, Geol. Magazine (London) 6 (1909) 411–413.

[10] Loc. cit. p. 25.

ILLUSTRATIONS

[Billitonites of various types, all from Sitio Pugad Baboy, Polo, Bulacan Province, Philippine Islands. Photographs by the Bureau of Science. Collection of F. W. McCaw.]

PLATE 1. BILLITONITES

FIG. 1. The spheroid type.
2. The cylindrical type.
3. The irregular type.

PLATE 2. BILLITONITES

FIG. 1. The drop type.
FIGS. 2, 3, and 4. Other forms of the irregular type. (These were not seen by the author.—V. ELICAÑO.)

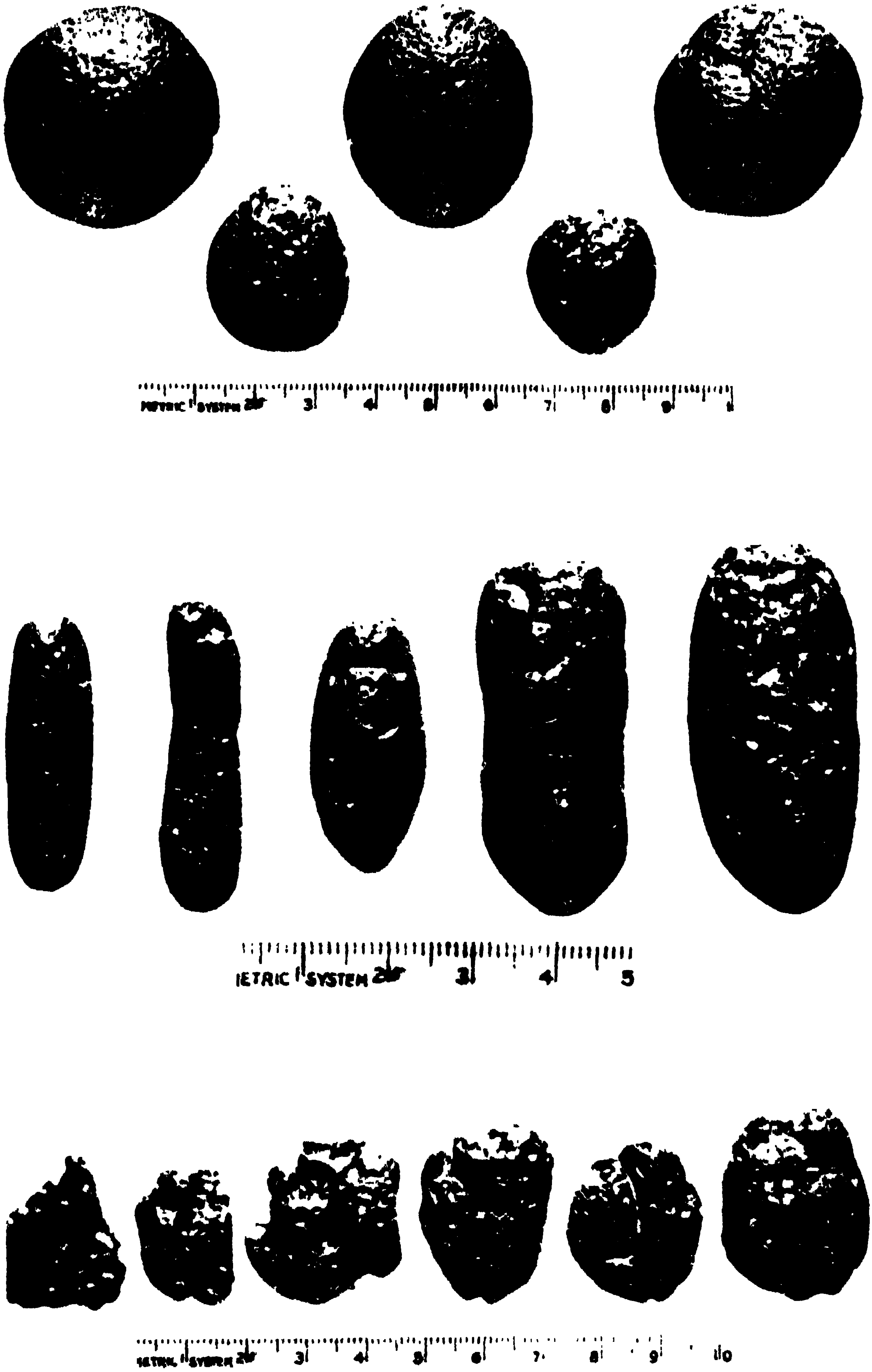

PLATE 1.

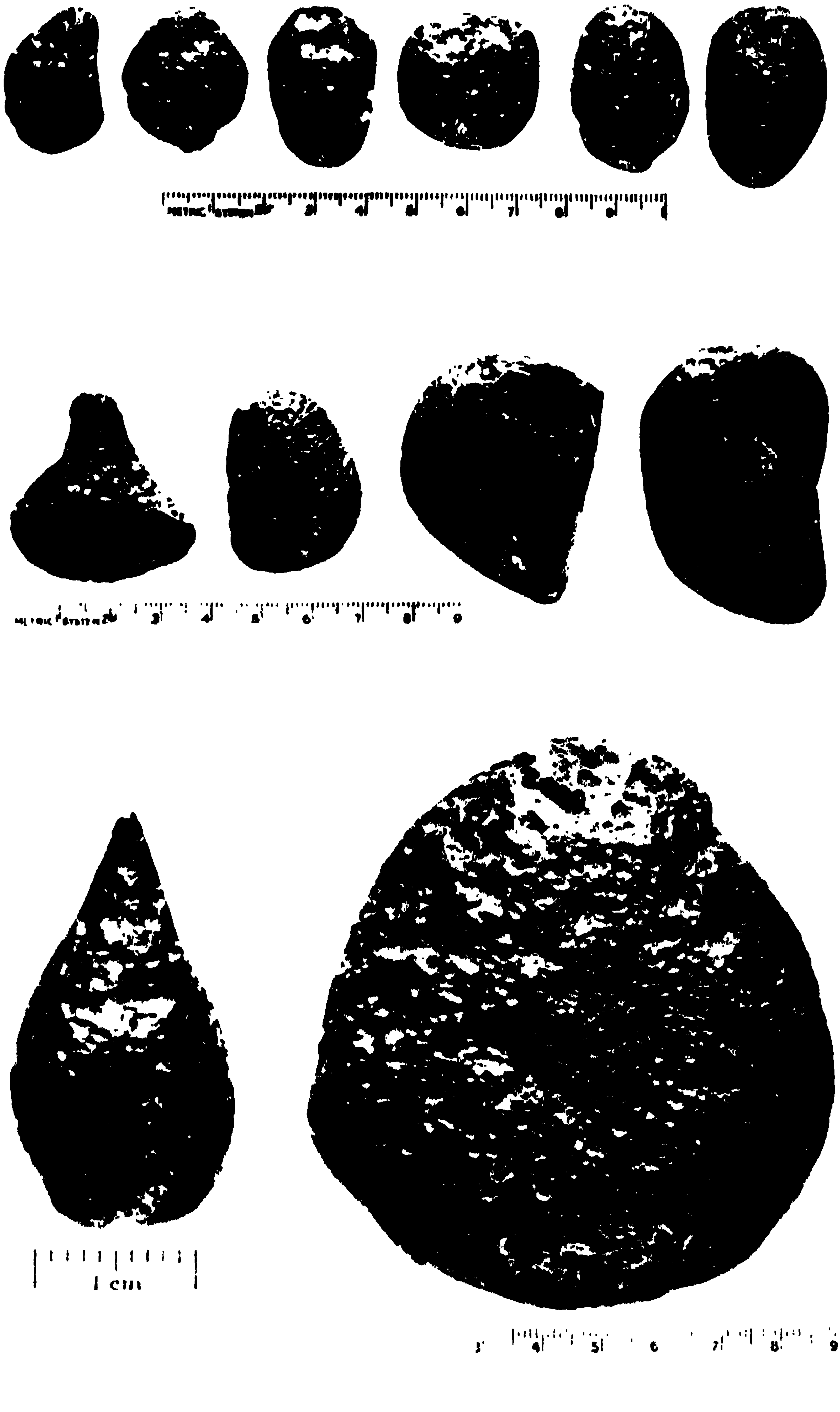

PLATE 2.

EXPERIMENTS ON THE TRANSMISSION OF SURRA BY MEANS OF THE DOG HOOKWORM ANCYLOSTOMA CANINUM[1]

By LOPE M. YUTUC

Of the College of Veterinary Science, University of the Philippines Los Baños, Laguna

The puzzling results obtained by myself and others during the study of equine surra and its chemotherapy have directed my attention to the probable rôle played by blood-sucking worms present in the digestive tract of animals affected with surra. Tubangui (1930), working on the same premises, conceived the idea that blood-sucking worms may be responsible for some of the relapses occurring in the course of the treatment of the disease. The hypothesis was advanced, supported by one positive experiment, that such parasites found in surra-infected animals probably ingest the trypanosome of the disease together with the blood and that they may also be capable of reinoculating it, in a virile state, to the host during subsequent feedings. If the theory is correct, how can the promising results obtained by Broudin (1927), Reynolds (1930), and others in experimental surra be explained? Is it possible that all the treated animals were free of every kind of gastrointestinal parasite at the time of the treatment? Unfortunately, whether or not the animals employed were examined for blood-sucking worms is not stated. Parasitism in the Tropics is so common as to suggest that the animals may have harbored some kind of blood-sucking helminths. If this statement is true, a question may arise. Is it possible for the trypanocidal drug to be ingested with the blood by the blood-sucking nematodes, thus making the blood inimical to the life of the trypanosome?

[1] The writer acknowledges with thanks his indebtedness to Dean Gregorio San Agustin, of the College of Veterinary Science, University of the Philippines, Los Baños, Laguna, for his interest and assistance, supplying him with material for this work.

The main object of the present paper is to elucidate the points mentioned above. Although the data here recorded are scarcely sufficient for final conclusions, it seems worth while to report the results.

MATERIALS AND METHODS

Sixteen dogs and twelve white rats were employed in this work. These species were selected mainly because of the ease with which the animals can be handled and their marked susceptibility to the disease. The organism (*Trypanosoma evansi*) employed was obtained from a horse suffering from surra brought for treatment to the clinic of the College of Veterinary Science, Los Baños, Laguna.

The procedure adopted in the determination of the presence of the trypanosome in the body of the hookworm (*Ancylostoma caninum*) consisted in crushing the engorged worms collected from a killed surra animal, mounting them in cover-slip preparations, and examining them immediately under the microscope. In conjunction with this method, some of the engorged hookworms were selected and triturated in a sterile mortar until reduced to fine, inoculable fragments. A small amount of sterile physiological salt solution was added to the material to increase the volume to a desired amount and then injected subcutaneously into the experimental animals.

The technic followed by Tubangui was also used either alone or in combination with the above method with a slight modification; namely, instead of using a canula in the insertion of the hookworms into the small intestine, the parasites were directly introduced through an enterotomy wound about 2 centimeters long and subsequently approximated with two or three stitches of Lambert suture. With this alteration the time consumed during the operation was reduced to an average of twenty minutes, and it seemed to be less injurious to the parasites. For details of the method the original paper should be consulted.

It should be noted that in the process of collecting the hookworms from the small intestines of the killed surra dogs, the worms close to and those in contact with the incisions when the intestines were laid open were discarded to avoid, as much as possible, contamination with the trypanosomes from the blood which oozed from the incision surfaces.

EXPERIMENTAL RECORDS

DETERMINATION OF THE PRESENCE OF TRYPANOSOMES IN THE BODY OF THE DOG HOOKWORM

Experiment 1.—June 20, 1930, dog 1, previously infected with surra, was killed fifteen days after infection, when the trypanosomes were numerous in the peripheral circulation. Thirty living hookworms were collected from its small intestine and washed five times with physiological salt solution to rid them of the mucoid material and other débris adhering to their bodies. Ten of the engorged worms were crushed and mounted on slides. Microscopic examination of the ten preparations revealed one trypanosome. The organism was motile and was believed to be *Trypanosoma evansi.* Some of the red blood cells as well as the white were noted intact in the preparations examined. The rest of the worms were triturated and injected into white rats 1 and 2. After seven days, rat 1 was found positive on microscopic examination of the blood obtained from the tail. Rat 2 remained negative and its susceptibility was later tested by injecting it subcutaneously with blood rich in trypanosomes.

DETERMINATION OF THE POSSIBLE ROLE OF THE DOG HOOKWORM IN THE ARTIFICIAL TRANSMISSION OF THE SURRA ORGANISM

Experiment 2.—May 17, 1930, ten living hookworms, some of them engorged with blood and collected from killed surra dog 2, were introduced into the small intestine of dog 3, through a surgical incision, which was afterwards sutured. Microscopic examination of the blood was made every day, and the animal remained negative to June 7, 1930, twenty-two days. The animal was tested for susceptibility and caught the disease eight days later. Dog 4 received simultaneously the same treatment as above. The result was the same as the former.

Experiment 3.—August 10, 1930, dog 3, previously inoculated with surra trypanosomes and the blood teeming with organisms, was killed, and twenty-five living hookworms were collected and washed several times with physiological salt solution. Each of two dogs (Nos. 5 and 6) received ten hookworms, which were introduced into the small intestine through a surgical wound; the wound was afterwards sutured. The rest of the worms collected were triturated with a small amount of sterile physio-

logical salt solution and injected into white rat 3. Observations were made in the same manner as in experiment 2. August 20, 1930, dog 5 was positive, and dog 6 and rat 3 remained normal, their susceptibility to the disease being later proven by inoculation with blood rich in trypanosomes.

Experiment 4.—Dog 5, having been found positive in experiment 3, was used as the source of the hookworms. August 26, 1930, the trypanosomes were numerous in the peripheral circulation, hence the animal was killed. Twenty-five hookworms were collected and washed four times with physiological salt solution to remove the mucoid material which adhered in the process of collection. Five of the engorged worms were triturated with a small amount of physiological salt solution, and injected into white rat 4, while the rest were transplanted into the intestines of dogs 7 and 8 through an incision of about 2 centimeters, the edges of which were afterwards approximated. Each animal received ten living hookworms. September 4, 1930, rat 4 was found positive by microscopic examination of the blood and died three days later. Dogs 7 and 8 did not get the infection and their susceptibility was later proven by inoculation with trypanosomes.

TO DETERMINE WHETHER OR NOT THE TRYPANOSOMES INGESTED BY HOOKWORMS OF SURRA-INFECTED ANIMALS ARE AFFECTED BY THE INJECTION OF A TRYPANOCIDAL AGENT

Experiment 5.—October 11, 1930, the source of hookworms was dog 8, which was previously infected, and when the trypanosomes were numerous in the peripheral circulation it was treated with sodium antimony tartrate, 0.004 gram for each kilogram of body live weight, given intravenously. A day after the treatment, the animal was killed, and twenty-six worms were collected and treated as in previous experiments. Three animals, dogs 9 and 10 and rat 5, were employed. Each dog was infected with ten living hookworms through an operative wound in the small intestine, and the rat was injected hypodermically with six triturated worms in a small amount of physiological salt solution. The blood of the animals was examined microscopically each day. All of them remained normal for twenty-five days after infection. Their susceptibility was later proven by inoculation with trypanosomes.

Experiment 6.—December 10, 1930, dog 9, having been previously infected with the trypanosomes of surra and treated

after two relapses of the disease, was given the same dose of antimony preparation as above. The next day the animal was killed, and the hookworms were collected and washed five times with physiological salt solution. Dogs 11 and 12 received ten living hookworms each by enterotomy, and white rat 6 received seven ground worms by subcutaneous injection. The results were negative. Their susceptibility was later proven by inoculation with trypanosomes.

Experiment 7.—January 23, 1931, dog 10, which had been infected with surra trypanosomes and at which time the peripheral circulation was teeming with the organisms, was treated with an intravenous injection of sodium antimony tartrate, 0.004 gram for each kilogram live weight. Four days later the animal was killed and thirty-two hookworms were collected and treated as in previous experiments. White rats 7 and 8 received subcutaneous injections of twelve ground engorged worms in sterile physiological salt solution. The rest of the hookworms were transplanted to dogs 13 and 14 by enterotomy, each animal receiving ten living hookworms. The following day dog 13 died, cause unknown. The rest remained negative for twenty days after operation. The susceptibility of the animals was later proven by injection with blood rich in trypanosomes.

Experiment 8.—November 1, 1931, dog 15 was infected with surra. After fifteen days the blood of the animal was swarming with surra organisms, and, the animal was subsequently subjected to sodium antimony tartrate treatment. The following day the dog was killed, and thirty living hookworms were collected and washed several times with physiological salt solution. Then they were ground in a sterile mortar until reduced to fine fragments. The volume of the material was increased to about 10 cubic centimeters with physiological saline. This was injected hypodermically into white rats 9 and 10, each receiving approximately 5 cubic centimeters of the preparation. Daily observations were made. Both rats remained negative. November 20, 1931, their susceptibility was proven by inoculation with trypanosomes.

Experiment 9.—November 24, 1931, dog 16, having been infected with surra organisms and treated with antimony preparation at the time the peripheral circulation was teeming with trypanosomes, was killed two days after the treatment. Thirty-six living hookworms were collected from the intestine and washed four times with physiological salt solution. The hook-

worms were triturated in a sterile mortar until converted into fine fragments. About 10 cubic centimeters of physiological salt solution was added to the material and then immediately injected subcutaneously into white rats 11 and 12. Daily microscopical observations of the tail blood were made. The rats remained negative to December 11, 1931, or fifteen days. Their susceptibility was later proven by inoculation with blood rich in trypanosomes.

DISCUSSION

Some of the experiments show that the trypanosomes of surra are actually found in the bodies of hookworms collected from surra-infected dogs, although not as numerous as I thought at one time. This may account in part for my failure to transmit the disease with regularity as may be noted in the above experiments. The positive results observed in experiments 1, 3, and 4 tend to strengthen the hypothesis propounded by Tubangui.

The negative results of experiments 5, 6, 7, 8, and 9 may suggest one of two things or both. First the trypanosomes ingested by the hookworms may be destroyed, probably due to the entrance of the trypanocidal drug into the body of the hookworms. Second, it is possible for some of the ingested trypanosomes of the hookworms, at the time the blood of the surra animal is made inimical to their existence by the administration of sodium antimony tartrate, to escape with the ejecta of the worms before being destroyed by the trypanocidal agent. This case deserves further inquiry, notwithstanding the fact that it finds support in the observation of Wells (1931) that a single hookworm possibly withdraws and ejects 0.8 cubic centimeter of blood from the host in twenty-four hours and that the ejecta consists mainly of red clood corpuscles of the host, together with some epithelial material and bacteria.

If such a state of affair exists in the horse as in the dog, this finding demonstrates the superfluity of the administration of anthelmintics with the specific object of expelling the blood-sucking worms and forestalling relapses of the disease in connection with the treatment of equine surra with trypanocidal drugs. However, it is possible that some of the blood-sucking worms may not be continually attached to the intestinal mucosa of their hosts. Besides, they need not be continually sucking. Furthermore, these blood-sucking parasites might be sensitive to the presence of the trypanocidal agents and for this reason abstain from feeding during such time as the drug is present in the

circulation in sufficient concentration to be injurious to them. All these considerations suggest the possibility of some trypanosome-harboring worms not injesting the trypanocidal drug. On the other hand, some of the trypanocidal agents, such as the antimony preparations, naganol, Fourneau 309, and others seem to be slowly eliminated from the system, rendering almost certain their being ingested by the blood-sucking parasites sooner or later during the course of the treatment of surra.

SUMMARY AND CONCLUSIONS

Experiments on the transmission of surra by means of the dog hookworm, *Ancylostoma caninum*, were performed.

It was determined by the injection and transplantation of hookworms from dogs infected with surra to normal animals that the surra trypanosome is ingested during the process of feeding and is retained in a viable state by the helminths.

On the other hand, no evidence was observed to show that the dog hookworm can act as a place of refuge for the trypanosome in the event the blood of an infected animal is made inimical to its well-being by the administration of a trypanocidal agent, such as antimony tartrate, for it appears that it is similarly destroyed in the digestive tract of the helminths by the drug.

For this reason the administration of anthelmintics for the expulsion of blood-sucking parasites with the specific object of preventing relapses during a course of treatment against surra does not appear to be of much value.

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NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), XV[1]

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THREE PLATES

The Tipulidæ collected in Davao district, Mindanao, in 1930 and 1931, by Mr. Charles F. Clagg, are further discussed at this time. All types are preserved in my collection.

TIPULINÆ

PSELLIOPHORA INVENUSTIPES sp. nov. Plate 1, fig. 1.

General coloration yellow, conspicuously variegated with black, including the occipital region of head and three clearly defined stripes on the mesonotal præscutum; legs black, unvariegated; wings dimidiate, the basal two-thirds yellow, the apical third, together with cells C, Sc, and Cu_1, dark brown; abdominal tergites yellow, trivittate with black.

Male.—Length, about 14 millimeters; wing, 14.5.

Frontal prolongation of head obscure yellow, dark brown laterally; nasus a little darker, tufted with yellow setæ; palpi pale yellow, the extreme tip of the terminal segment dark brown. Antennæ with the scape obscure yellow; remaining segments, including the pedicel, black. Head orange, the occipital area black and very extensive.

Pronotum yellow medially, blackened laterally. Mesonotal præscutum yellow, with three very distinct brownish black stripes, the median one not quite attaining the suture; lateral stripes crossing the suture onto the scutal lobes which are largely covered by these areas; remainder of mesonotum yellow, the scutellum with a median infuscation; postnotal mediotergite with paired brown spots on caudal half. Pleura chiefly yellow, the ventral sternopleurite and meral region infuscated. Halteres brownish black, the basal fourth of stem yellow. Legs with

[1] Contribution from the entomological laboratory, Massachusetts State College.

the coxæ yellow, narrowly margined with brown at base; trochanters obscure brownish yellow; remainder of legs entirely black. Wings (Plate 1, fig. 1) dimidiate, cells C, Sc, and Cu_1, together with the stigma, dark brown; basal two-thirds of remainder of wing yellow, with vague dusky streaks in centers of major cells; distal third of wing, including all cells beyond cord, uniformly dark brown, paler than the costal darkening. Venation: Cell M_1 sessile.

Abdominal tergites yellow, trivittate with black; median areas of segments two to four broadly interrupted by yellow at caudal margins; on succeeding tergites the black median areas become more extensive; lateral dark stripes beginning on outer half of tergite two, on succeeding three segments narrowly interrupted by yellow on basal portion of each tergite, on outer segments more continuous; sternites yellow, clearer on caudal margin; sternites four and five with a small darkened basal triangle; hypopygium chiefly yellow, the tergal portions and styli black. Male hypopygium with the eighth sternite produced medially into a conspicuous dusky lobe that bears abundant golden setæ.

MINDANAO, Davao district, Calian, Sibulan Barrio, flying in field of abacá at foot of Mount Apo, altitude 2,000 feet, October 8, 1930 (*Clagg*); holotype, male.

Pselliophora invenustipes is quite distinct from all other regional species in the uniformly blackened legs, in conjunction with the pattern of the body and wings. By Edwards's key to the Philippine species of *Pselliophora* [2] the fly runs to couplet 3, agreeing most closely with *P. perdecora* Alexander, which has an entirely different wing pattern.

DOLICHOPEZA (NESOPEZA) PERDITA sp. nov. Plate 1, fig. 2; Plate 2, fig. 21.

Most closely allied to *abdita;* mesonotal præscutum pale brown, unmarked; posterior sclerites of mesonotum dark brown; pleura pale; femora and tibiæ dark, the posterior tarsi entirely white; wings narrow, long-petiolate basally; Rs long; male hypopygium with the caudal margin of tergite bearing two large blackened teeth; inner dististyle unusually narrow, boomerang-shaped.

Male.—Length, about 9 to 10 millimeters; wing, 11 to 11.5.

Frontal prolongation of head brownish yellow; palpi dark brown. Antennal scape and pedicel obscure yellow; flagellum black; antennæ about as long as the combined head and thorax; flagellar segments with verticils that are much shorter than

[2] Notulæ Entomologicæ 6 (1926) 41.

the segments. Head pale brown, with a large, darker brown spot on either side of posterior vertex, extending from eye to occiput.

Mesonotal præscutum pale brown, without evident markings; posterior sclerites of mesonotum dark brown, including the pleurotergite. Pleura yellow. Halteres dusky, the knobs dark brown. Legs with the coxæ yellow; trochanters testaceous yellow; femora dark brown, the bases restrictedly pale; tibiæ black, the posterior tarsi entirely snowy white; mid-tarsi with almost all of basitarsi black, the tips and remainder of tarsi white; forelegs broken. Wings (Plate 1, fig. 2) with a brown tinge, the oval stigma darker brown; obliterative areas before and beyond the stigma and across the fork of M poorly defined; veins dark brown. Wings much narrower than in *abdita*, conspicuously petiolate at base. Venation: Rs elongate, more than one-third longer than R_{2+3}; cells beyond cord narrower than in *abdita;* cell 2d A narrow.

Abdominal tergites brownish black; basal sternites obscure yellow; hypopygium dark. Male hypopygium (Plate 2, fig. 21) with the ninth tergite, *9t*, produced on either side into a powerful blackened tooth, the median region very feebly produced; ventral extensions of tergal lobes slender, the tips bidentate, but without other serrulations. Eighth sternite, *8s*, pale, narrowed outwardly, the caudal margin medially very gently emarginate, on either side of midline with a denser grouping of weak setæ. Inner dististyle, *id*, unusually narrow, boomerang-shaped, the base weakly setiferous, the apex truncated.

MINDANAO, Davao district, Calian, Mount Apo, Todaya Plateau, altitude 5,000 feet, November 11, 1930 (*Clagg*); holotype, male; paratype, male.

Dolichopeza (*Nesopeza*) *perdita* is allied to *D.* (*N.*) *abdita* Alexander (Mindanao) in the elongate Rs, unmarked wings, and general pattern of the legs. It is very different in the narrow, long-petiolate wings and the structure of the male hypopygium, especially the toothing of the tergite and the very narrow inner dististyle. In *abdita*, the inner dististyle is unusually broad and flattened.

DOLICHOPEZA (NESOPEZA) QUERIBUNDA sp. nov. Plate 1, fig. 3; Plate 2, fig. 22.

Belongs to the *gracilis* group; most nearly allied to *nigrofemorata;* general coloration of mesonotum yellowish brown, without distinct markings; tibiæ infuscated, paling to obscure

whitish before tips; wings with a brown tinge, the costal border dark brown, not abruptly brightened in outer end of cell R_2; male hypopygium with the lateral lobes of the ninth tergite very broad, truncated; eighth sternite with a row of long setæ on either lateral lobe, these becoming progressively shorter toward the midline.

Male.—Length, about 8 to 9 millimeters; wing, 9 to 10.5.

Frontal prolongation of head dark brown; palpi black. Antennæ with the scape, pedicel, and base of first flagellar segment yellow, the remainder of organ dark brown; flagellar segments cylindrical, with scanty, very short verticils that scarcely exceed in length the abundant white pubescence. Head light brown, the anterior vertex a trifle brighter.

Mesonotal præscutum and scutum yellowish brown, the former a little darker on cephalic third but not otherwise marked; scutellum and postnotal mediotergite a trifle darker. Pleura light brown, the dorsopleural region and pteropleurite more yellowish. Halteres yellow, the knobs dark brown. Legs with the coxæ and trochanters testaceous-yellow; femora brown, more yellow at base; tibiæ infuscated, passing to obscure whitish before the very narrow dark brown tips; proximal ends of basitarsi narrowly darkened; remainder of tarsi white. Wings (Plate 1, fig. 3) with a brownish tinge, the costal border dark brown; central portion of cell R_2 paler but without abruptly delimited white central areas, as in most species of the group; posterior extensions along origin of Rs and at cord narrower than in *nigrofemorata*. Venation: Cell 2d A narrow.

Abdominal tergites brownish black, the bases of the segments narrowly brightened, the outer segments uniformly blackened; sternites yellow on basal portion, the distal half or more brownish black; hypopygium brownish black. Male hypopygium (Plate 2, fig. 22) with the ninth tergite, *9t*, transverse, the lateral lobes very broad, truncated; median lobe low and obtuse. Apical lobe of inner dististyle, *id*, elongate. Eighth sternite, *8s*, transversely rectangular, the caudal margin gently emarginate; lateral lobes with a fringe of long black setæ, the outer ones longest, gradually decreasing in length toward the median line.

MINDANAO, Davao district, Mati, Mount Mayo, altitude 5,000 feet, January 27, 1931 (*Clagg*); holotype, male; paratypes, 2 males.

By my key to the Philippine species of *Dolichopeza*[3] the present species runs to *D.* (*N.*) *nigrofemorata* Alexander (Mindanao) which is very distinct in the structure of the male hypopygium. The present fly is well differentiated by the very broad, truncated lobes of the tergite and the arrangement and nature of the setæ on the eighth sternite.

DOLICHOPEZA (NESOPEZA) LUDIBUNDA sp. nov. Plate 2, fig. 23.

Belongs to the *gracilis* group; most nearly related to *nigrofemorata* and *queribunda;* general coloration of mesonotum light brown, without distinct markings; wings with a dark costal pattern; cell R_2 variegated by a single pale area; male hypopygium with the lateral lobes of the tergite small, narrower than the median notch separating them; caudal margin of eighth sternite nearly transverse, with weak setæ that are not grouped into tufts or brushes.

Male.—Length, about 8 millimeters; wing, 8.2.

Frontal prolongation of head testaceous-yellow; palpi dark brown. Antennæ (male) elongate, if bent backward extending about to root of halteres; scape, pedicel, and basal segment of flagellum yellow, the remainder of organ passing to brown; flagellar segments cylindrical, clothed with an abundant white pubescence; verticils scarcely developed. Head pale yellowish brown.

Mesonotum light brown, the præscutum with scarcely apparent stripes; posterior sclerites of mesonotum more infuscated. Pleura almost uniformly brownish yellow, the anepisternum a trifle more darkened. Halteres with the stem pale brown, the knobs brownish black. Legs with the coxæ and trochanters pale yellow; remainder of legs broken. Wings of the general type of *nigrofemorata*, including a dark costal pattern that is almost continuous, being interrupted by a single pale area in cell R_2. Venation: Forks of medial field deep.

Abdominal tergites brownish black medially, the individual segments variegated laterally with yellow on basal half; hypopygium dark. Male hypopygium (Plate 2, fig. 23) with the ninth tergite, *9t*, small, the lateral lobes glabrous, blackened, the median notch evenly rounded, wider than the diameter of either lateral lobe. Eighth sternite, *8s*, pale, the caudal margin nearly transverse and with few outstanding bristles, the most evident

[3] Philip. Journ. Sci. 47 (1932) 169–171.

grouping being a linear arrangement of from six to eight shorter, more spinous setæ on either side of median line.

MINDANAO, Davao district, Mati, Mount Mayo, altitude 5,000 feet, January 28, 1931 (*Clagg*); holotype, male.

By my key to the Philippine species of *Dolichopeza*[4] the present fly runs to *nigrofemorata* Alexander, to which species and *D.* (*N.*) *queribunda* sp. nov. it is most nearly allied. The outline of the ninth tergite and the setal armature of the eighth sternite are distinctly different from the same features in these or any other described regional species.

DOLICHOPEZA (NESOPEZA) EVANIDA sp. nov. Plate 2, fig. 24.

Belongs to the *gracilis* group; general coloration of mesonotum pale, the præscutum with three dark brown stripes; pleura pale, conspicuously variegated with brown areas; male hypopygium with the median region of the eighth sternite produced caudad beyond the level of the lateral lobes, the latter with a row of stout spines.

Male.—Length, about 9 millimeters; wing, 8.5.

Frontal prolongation of head and the palpi dark brown. Antennæ with the three basal segments yellowish, the outer segments more infuscated; antennæ relatively long; flagellar segments long-cylindrical, with short verticils. Head light brown.

Mesonotal præscutum obscure whitish, with three dark brown stripes, the median one further divided by a capillary darker brown line; scutal lobes conspicuously marked with dark brown, the anterior darkened area circular in outline, sending a narrower darkening backward; posterior sclerites of mesonotum brown. Pleura pale, almost white, variegated by dark brown areas that include the ventral sternopleurite, meral region, anepisternum, cephalic edge of pteropleurite, pleurotergite, and the fore coxæ. Halteres elongate, pale, the knobs dark brown. Legs with the fore coxæ dark brown, the remaining coxæ and all trochanters yellow; femora yellow, the tips broadly dark brown; tibiæ chiefly yellow, the outer end more golden yellow, the basal portion weakly darkened; tarsi white. Wings subhyaline, with the usual dark brown costal pattern of the *gracilis* group, the dark color variegated by pale spots in outer ends of cells R_2 and R_3; veins dark. Venation: Medial forks deep.

Abdominal tergites dark brown, the basal segments variegated

[4] Loc. cit.

with obscure yellow just before the caudal margins, the outer segments more uniformly darkened; sternites clearer yellow, the caudal margin and basal ring of the individual segments more darkened. Male hypopygium (Plate 2, fig. 24) with the median region of the tergite, *9t*, produced into a low protuberance, the lateral lobes obliquely truncated, the ventral surface produced into spinose lobes. Eighth sternite, *8s*, with the median area produced caudad beyond the level of the lateral lobes, unarmed except for delicate setulæ; lateral lobes low, lying close to the median area, each armed with a row of powerful spines.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, December 31, 1930 (*Clagg*); holotype, male.

Dolichopeza (*Nesopeza*) *evanida* is quite distinct from the allied *D.* (*N.*) *paucispinosa* Alexander (Mindanao) in the details of structure of the male hypopygium, especially of the eighth sternite. By my key to the Philippine species of the genus [5] the fly runs directly to *paucispinosa*.

DOLICHOPEZA (NESOPEZA) PUDIBUNDA sp. nov. Plate 2, fig. 25.

Belongs to the *gracilis* group; general coloration of mesonotal præscutum obscure yellow, the usual stripes reddish brown and poorly delimited; pleura pale, conspicuously variegated with brown; wings with the usual dark costal pattern of the group, the outer ends of cells R_2 and R_3 variegated with pale spots; male hypopygium with the caudal margin of the eighth sternite gently emarginate, provided with four groups of setæ, the lateral groups slenderer and arranged in coarse pencils, the submedian groups distributed in a linear series, shorter and more spinous.

Male.—Length, about 9 millimeters; wing, 8.5.

Female.—Length, about 11 millimeters; wing, 9.

Frontal prolongation of head and palpi dark brown. Antennæ pale yellowish brown, in male relatively long, if bent backward extending about to base of abdomen; flagellar segments long-cylindrical, with short, inconspicuous verticils. Head brown.

Mesonotal præscutum obscure yellow, with scarcely differentiated reddish brown stripes; posterior sclerites of mesonotum light brown. Pleura pale, conspicuously variegated with brown on the ventral sternopleurite, meral region, anepisternum, and fore coxæ. Halteres long, pale yellow, the knobs dark brown. Legs with the fore coxæ dark, the remaining coxæ and all tro-

[5] Loc. cit.

chanters yellow; femora yellow, the tips narrowly dark brown; tibiæ whitish, the tips very narrowly and weakly darkened; tarsi white. Wings as in the *gracilis* group, the outer ends of cells R_2 and R_3 variegated with large pale spots; veins pale brown.

Abdominal tergites dark brown, before their caudal margins with a median yellow area; sternites yellow, narrowly marked with dark brown at near midlength and again at caudal margin. Male hypopygium (Plate 2, fig. 25) with the median region of the tergite, *9t*, produced, the lateral lobes relatively small and inconspicuous. Eighth sternite, *8s*, only gently emarginate across its caudal margin, provided with four groups of setæ and weak spines, as follows: Outer lateral angles with pencils of more elongate setæ; on either side of median line, the caudal margin with a linear series of shorter and stouter, more spinous setæ; disk of sternite with two linear rows of punctures, converging behind.

MINDANAO, Davao district, Calian, Mount Apo, Baroring River, altitude 6,000 feet, November 10, 1930 (*Clagg*); holotype, male; allotype, female.

By my key to the Philippine species of *Dolichopeza*[6] the present species runs to *D.* (*N.*) *paucispinosa* Alexander, to which species and to *D.* (*N.*) *evanida* sp. nov. it is most closely allied. All three species are readily told among themselves by the details of structure of the male hypopygium, especially the conformation of the eighth sternite and the arrangement of setæ and spines thereon.

LIMONIINÆ

LIMONIINI

LIMONIA (LIBNOTES) TENUICLAVA sp. nov. Plate 1, fig. 4; Plate 2, figs. 26, 27.

General coloration of mesonotum dark brown, the pleura brownish yellow with a dorsal black longitudinal stripe; antennæ (male) nodulose, the segments with long glabrous apical necks; halteres darkened; femora dark brown, the tips narrowly yellow; wings with a faint brown tinge, the costal region a little darker; m-cu just before midlength of cell 1st M_2; anal veins parallel at origin; male hypopygium with the basistyles elongate, the ventromesal lobe unusually slender; inner dististyle a low oval fleshy lobe, the outer margin extended into a

[6] Loc. cit.

hornlike portion that bears about seven flattened teeth to form a comblike structure.

Male.—Length, about 4 millimeters; wing, 4.5.

Rostrum and palpi brownish black. Antennæ (male) relatively elongate, nodulose (Plate 2, fig. 26); black throughout; individual flagellar segments enlarged, suboval, with abundant long erect delicate setæ and still longer, unilaterally arranged verticils on outer face; apical pedicels very long, on basal flagellar segments nearly equal in length to the enlargements, becoming shorter on the outer segments, on the penultimate about one-half the enlarged portion; terminal segment elongate, gradually narrowed to the apex. Head dark colored.

Mesonotum badly discolored, dark brown or brownish black medially, the præscutum extensively pale brown on sides. Pleura brownish yellow, the anepisternum and propleura blackened, producing a dark dorsolongitudinal area. Halteres brownish black, the base of stem narrowly pale. Legs with the fore coxæ blackened, the remaining coxæ and all trochanters yellow; femora dark brown, the tips narrowly and abruptly light yellow; tibiæ and tarsi pale brown to yellowish brown. Wings (Plate 1, fig. 4) with a faint brownish tinge, the costal region and a seam along vein Cu_1 somewhat darker; stigma very small, darker brown; veins and macrotrichia dark brown. Macrotrichia of veins very long; costal fringe of moderate length only. Venation: Sc of moderate length, Sc_1 ending beyond fork of Rs but before level of r-m, Sc_2 at its tip; Rs arcuated; free tip of Sc_2 lying a little proximad of R_2; m-cu just before midlength of cell 1st M_2; anal veins parallel at origin.

Abdomen chiefly dark brown, the incisures somewhat paler; hypopygium dark. Male hypopygium (Plate 2, fig. 27) with the tergite, *9t*, gently emarginate, each lobe slightly rounded and provided with four or five setæ. Basistyle, *b*, long and narrow, its ventromesal lobe subbasal in position, unusually slender. Dorsal dististyle, *dd*, a slightly curved, sclerotized rod, the tip acute. Ventral dististyle, *vd*, of peculiar structure, appearing as a flattened, oval, fleshy lobe, the mesal portion produced into a rostrum; on outer margin of style a hornlike extension that bears a series of about seven flattened comblike darkened teeth, the outer ones broader. Gonapophyses, *g*, with the mesal lobe elongate, flattened, the tip obtuse.

MINDANAO, Davao district, Mati, Mount Mayo, altitude 5,000 feet, January 28, 1931 (*Clagg*); holotype, male.

By Edwards's key to the species of *Libnotes*[7] the present species runs to couplet 61, disagreeing with all species beyond this point in coloration, and especially in the peculiar structure of the male hypopygium. The fly is amply distinct from other species of *Libnotes* known from the Philippines. The elongate, nodulose antennæ remind one of the condition found in the closely allied subgenus *Limonia* (as *multinodulosa* Alexander) but the present fly certainly belongs to *Libnotes*.

LIMONIA (LIMONIA) PATULA sp. nov. Plate 1, fig. 5; Plate 2, fig. 28.

General coloration of mesonotum light yellowish brown, the dorsal thoracic pleurites darkened; eyes contiguous above; halteres darkened; legs pale brown, the tips of the femora and tibiæ very narrowly darkened; wings subhyaline, the brown stigma nearly circular in outline; male hypopygium very complex in structure, especially the basistyle which is extended ventrally and bears numerous apical lobes.

Male.—Length, about 5 millimeters; wing, 5.5.

Female.—Length, about 5.5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ brownish black; flagellar segments oval to short-cylindrical; terminal segment elongate, one-half longer than the penultimate, narrowed outwardly; verticils relatively short and inconspicuous. Eyes contiguous on vertex, separating the anterior vertex from the posterior sclerites of head; ommatidia relatively coarse. Head gray.

Mesonotum light yellowish brown. Pleura yellow, the dorsal sclerites more infuscated. Halteres dark brown, the base of stem narrowly yellow. Legs with the fore coxæ darkened, remaining coxæ and all trochanters yellow; remainder of legs very pale brown, the tips of the femora and tibiæ very narrowly and weakly darkened. Wings (Plate 1, fig. 5) subhyaline, the pale brown stigma nearly circular in outline; veins brown. Venation: Sc_1 ending about opposite two-thirds Rs, Sc_2 close to its tip; Rs long, gently arcuated, approximately four times the basal section of R_{4+5}; free tip of Sc_2 and R_2 nearly in transverse alignment; m-cu at fork of M; vein 2d A converging gently toward 1st A at base, thence gently sinuous to margin.

Abdominal tergites dark brown, the sternites yellow; in male, the caudal margins of the individual tergites narrowly pale; hypopygium dark. Male hypopygium (Plate 2, fig. 28) very complex in structure. Ninth tergite, *9t*, with the caudal margin

[7] Journ. Fed. Malay States Mus. (1928) 74–80.

convexly rounded, the median portion slightly emarginate; setæ of tergite relatively few in number. Basistyle, *b*, extensive, very complicated by lobes as shown (drawn from a dissected mount, to show relative position); in addition to the lobes, the basistyle bears a flattened sclerotized plate with about three or four long setæ near its base. Dorsal dististyle, *dd*, a straight rod, narrowed to the subacute tip, the surface of style with microscopic setulæ. Ventral dististyle, *vd*, an oval fleshy lobe, with an elongate rostral prolongation that is bent at near midlength at a right angle. Gonapophyses, *g*, elongate, subtending the ædeagus, sinuous and angularly bent at near midlength, the tips obtusely rounded.

MINDANAO, Davao district, Calian, Mount Apo, Baroring River, altitude 6,000 feet, November 10, 1930 (*Clagg*); holotype, male; allotype, female.

In the remarkable development of lobes on the basistyle and the peculiar structure of the dististyles of the male hypopygium, the present species is approached by three allied regional species, *Limonia* (*Limonia*) *bilobulifera* Alexander (Luzon), *L.* (*L.*) *davaoensis* Alexander (Mindanao), and *L.* (*L.*) *pendleburyi* (Edwards) (Federated Malay States), differing from all in the much greater complexity of the male hypopygium, notably of the basistyles and dististyles.

LIMONIA (LIMONIA) DESIDERATA sp. nov. Plate 1, fig. 6.

General coloration light ocherous yellow; thoracic pleura with a brown longitudinal stripe; halteres dusky, the base of stem yellow; legs yellow; wings pale yellow, the stigma brown; Sc_1 ending about opposite one-third the length of Rs; cell 1st M_2 open by the atrophy of the basal section of M_3, cell 2d M_2 small; abdominal tergites bicolorous, dark brown, conspicuously ringed on caudal margins with light yellow.

Female.—Length, about 5 millimeters; wing, 4.

Rostrum and palpi brown. Antennæ dark throughout; flagellar segments oval, with verticils that slightly exceed the segments; terminal segments elongate. Head dark colored.

Mesonotum light ocherous yellow, the præscutum without distinct stripes; scutal lobes slightly darkened; scutellum testaceous yellow; postnotal mediotergite weakly darkened. Pleura obscure yellow, with a distinct brown longitudinal stripe extending from the propleura, passing beneath the root of the halteres to the abdomen; ventral sternopleurite darkened. Halteres dusky, the base of stem narrowly yellow. Legs with the coxæ

and trochanters yellowish testaceous; remainder of legs yellow, the terminal tarsal segments darkened. Wings (Plate 1, fig. 6) with a pale yellow tinge, the short-oval stigma brown; scarcely evident darker clouds at origin of Rs and along cord; veins brownish yellow. Macrotrichia of veins relatively numerous, quite lacking on Sc. Venation: Sc_1 ending about opposite one-third the length of Rs, Sc_2 some distance from its tip, lying just distad of origin of Rs; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 open by the atrophy of the basal section of M_3; cell 2d M_2 small, about three-fifths as long as its petiole; m-cu at fork of M, longer than the distal section of Cu_1; anal veins gently converging at bases, thence gradually diverging.

Abdominal tergites dark brown, conspicuously ringed on their caudal margins with light yellow, the color becoming narrower and more obscure on segments six and seven; genital segments yellow; sternites obscure yellow, the basal two-thirds of the individual segments more yellowish brown. Ovipositor with the tergal valves slender, gently upcurved.

MINDANAO, Davao district, Calian, Mount Apo, Galog River, altitude 6,000 feet, September 8, 1930 (*Clagg*); holotype, female.

Limonia (*Limonia*) *desiderata* is quite distinct from all other regional species of *Limonia*. The only other species of the subgenus having cell 1st M_2 open by the atrophy of the basal section of M_3 is *L.* (*L.*) *bagobo* Alexander, an otherwise very different fly. The possibility exists that the unique type may have an abnormal venation, but this is similar on the two wings and certainly appears to represent a normal condition. If the basal section of M_3 was abnormally lost in this type, cell 1st M_2 would necessarily be of a most unusual length in the present group of crane flies. The general appearance of the fly is quite distinct from that of any species of *Limonia* or *Dicranomyia* in Mindanao.

LIMONIA (DICRANOMYIA) PUNCTULATOIDES sp. nov. Plate 1, fig. 7; Plate 2, fig. 29.

Belongs to the *punctulata* group; male hypopygium with the rostral prolongation of the ventral dististyle with two long slender spines, arising close together from scarcely developed basal tubercles; gonapophyses with the mesal apical angles long and slender, the margins smooth.

Male.—Length, about 5 to 5.5 millimeters; wing, 6 to 6.5.

Female.—Length, about 5.5 to 6 millimeters; wing, 6 to 6.5.

Rostrum and palpi black. Antennæ with the scapal segments black, the flagellum somewhat paler; flagellar segments short-

oval, the outer segments a trifle more elongate; terminal segment large. Head brownish gray.

Mesonotum brownish gray, the præscutum with two intermediate darker brown stripes, the usual lateral stripes poorly indicated; scutal lobes brown; scutellum and postnotal mediotergite light gray. Pleura dark brownish gray. Halteres pale, the base of knobs weakly darkened. Legs with the coxæ dark brown; trochanters yellowish brown to brown; femora yellowish brown, a little darker outwardly; tibiæ and tarsi brownish yellow. Wings (Plate 1, fig. 7) as in *punctulata* and allies, whitish subhyaline, with a spotted and dotted brown and gray pattern; a series of six to eight dots in cell C; an oval spot at about one-third the length of vein M; the usual two spots on vein 2d A; a variable number of small washes in cell M adjoining vein Cu_1; other darkened dots along cord, outer end of cell 1st M_2, along margin of wing at ends of longitudinal veins, and as variable clouds along R_{4+5}; veins pale, darker in the clouded areas. Venation: Sc_1 ending opposite origin of Rs. Sc_2 near its tip; Rs straight; cell 1st M_2 long, about equal to vein M_{1+2} beyond it.

Abdomen dark brown. Male hypopygium (Plate 2, fig. 29) with the ninth tergite, *9t*, notched medially. Ventral dististyle, *vd*, large and fleshy, the rostral prolongation with two relatively long slender spines that arise close together at beyond midlength of the prolongation from very small basal tubercles. Gonapophyses, *g*, with the mesal apical angle elongate, slender, the margins smooth.

MINDANAO, Davao district, Calian, Mount Apo (*Clagg*); holotype, male, altitude 6,000 feet, October 18, 1930; allotype, female, with the type; paratypes, 6 males and females, altitude 6,000 to 6,500 feet, September 14 to November 10, 1930.

Limonia (*Dicranomyia*) *punctulatoides* is most nearly allied to *L.* (*D.*) *subpunctulata* Alexander (Formosa) in the bispinous rostral prolongation of the male hypopygium and the untoothed lobes of the gonapophyses. It differs conspicuously in the long rostral spines and the very long, slender, mesal-apical lobes of the gonapophyses.

LIMONIA (DICRANOMYIA) MORONIS sp. nov. Plate 2, fig. 30.

Belongs to the *morio* group; most nearly allied to *benguetensis*; male hypopygium with the rostral prolongation of the ventral dististyle bearing a conspicuous pale spine; apex of dorsal dis-

tistyle obliquely truncated, entirely straight and unnotched; gonapophyses with the mesal-apical lobe very broad.

Male.—Length, about 5.5 to 6.5 millimeters; wing, 6 to 7.5.

Female.—Length, about 5.5 to 6 millimeters; wing, 5.5 to 6.

Rostrum black dorsally, brownish yellow laterally; palpi black. Antennæ black throughout; flagellar segments oval, becoming more elongate outwardly, the verticils slightly exceeding the segments; terminal segment long, about one-third longer than the penultimate, constricted at near midlength. Front and the broad anterior vertex silvery white; posterior portions of head black, sparsely pruinose.

Mesonotum polished black, the humeral region of præscutum a little brightened; posterior margin of scutellum obscure yellow. Pleura black, with a heavy silvery pruinosity on propleura, dorsal anepisternum, ventral sternopleurite, and meral region. Halteres brownish black, the basal half or more of stem yellow. Legs with the fore coxæ blackened, the remaining coxæ and all trochanters yellow; remainder of legs black, the femoral bases restrictedly obscure yellow. Wings with a strong brown tinge, the oval stigma darker brown; veins brown. Venation: Sc_1 ending opposite or just before the origin of Rs, the latter long, in alignment with R_{2+3}; m-cu at or before fork of M.

Abdominal segments conspicuously ringed with black and obscure yellow, the bases of the segments black, the caudal margins yellow, the amount of the latter decreasing on the outer segments; terminal segments, including the hypopygium, entirely black. Male hypopygium (Plate 2, fig. 30) with the structure of the tergite, *9t*, and basistyle, *b*, almost as in *benguetensis*. Ventral dististyle, *vd*, with a single conspicuous pale spine on rostral prolongation. Dorsal dististyle, *dd*, with the apex obliquely truncated, not notched. Gonapophyses, *g*, with the mesal-apical lobes very broad.

MINDANAO, Davao district, Calian, Mount Apo, Lake Lino and Kidapawan trail, altitude 7,000 to 8,000 feet (*Clagg*); holotype, male; allotype, female, September 19, 1930; paratypes, 5 of both sexes, September 19 and 20, 1930.

Limonia (*Dicranomyia*) *moronis* is close to *L.* (*D.*) *benguetensis* Alexander (Luzon), differing most conspicuously in the structure of the dorsal dististyle and gonapophyses of the male hypopygium.

LIMONIA (GERANOMYIA) IMMOBILIS sp. nov. Plate 1, fig. 8; Plate 2, fig. 31.

Mesonotal præscutum buffy yellow, with three narrow blackish stripes; rostrum and antennæ entirely black; head blackish, with a narrow median gray line extending from front to occiput; femora black, except at bases; wings with a heavy brown pattern, the areas at origin of Rs and tip of Sc separated; Sc long; m-cu some distance before fork of M; male hypopygium with the two rostral spines arising from a common base; gonapophyses with the mesal-apical lobe irregularly toothed along inner margin.

Male.—Length, excluding rostrum, about 5 millimeters; wing, 5.6 to 5.8; rostrum, about 1.7 to 1.8.

Female.—Length, excluding rostrum, about 5.5 millimeters; wing, 6; rostrum, about 2.

Rostrum black throughout, relatively short and powerful; palpi black. Antennæ black throughout; flagellar segments short-oval to subcylindrical, the verticils short and inconspicuous. Posterior vertex blackish, the front, anterior vertex, and a posterior extension of the latter to the occiput light gray; anterior vertex narrower than the diameter of the scape.

Pronotum ocherous yellow, with a narrow black median line; lateral margins narrowly darkened. Mesonotal præscutum buffy yellow, the lateral margins paling to light gray; three narrow blackish stripes, the median one a direct posterior extension of the pronotal median darkening, the stripe paling to gray before the suture; lateral stripes narrow but long, separated from the median line by interspaces of about equal width; scutal lobes brownish gray, each marked near mesal edge by a brown line; scutellum buffy, with a median black line that is continued cephalad onto the median region of the scutum; postnotal mediotergite brownish gray. Pleura with the sternopleurite light yellow, the remainder of pleura chiefly dark brown, sparsely pruinose. Halteres yellow, the knobs dark brown. Legs with the coxæ and trochanters yellow; femora black, the bases narrowly yellow; tibiæ brown, the tips weakly darkened; tarsi yellow, the tips of the basal segments narrowly darkened, the terminal segments brownish black. Wings (Plate 1, fig. 8) whitish subhyaline, the prearcular region light yellow; a heavy brown pattern, arranged as a series of about seven costal areas, the third at origin of Rs, fourth at tip of Sc_1, fifth, largest, at

stigma; additional dark areas at fork of Rs, on anterior cord, m-cu, outer end of cell 1st M_2 and a marginal series at outer ends of cells 2d M_2 and M_4, and at ends of both anal veins; veins brown, costal and subcostal veins yellow, dark brown in the darkened areas. Costal fringe short. Venation: Sc long, Sc_1 ending opposite three-fifths to three-fourths the length of Rs, Sc_2 near its tip; cell 1st M_2 long, subequal to vein M_{1+2} beyond it; m-cu from two-thirds to three-fourths its own length before the fork of M; anal veins at origin nearly parallel.

Abdominal tergites dark brown, the sternites obscure yellow, darker on outer segments. Male hypopygium (Plate 2, fig. 31) with the caudal margin of the ninth tergite, *9t*, gently emarginate. Ventral dististyle, *vd*, large and fleshy, much larger than the basistyle, *b;* rostral prolongation with two relatively long, gently curved spines from a common basal tubercle. Gonapophyses, *g*, with the mesal-apical lobe elongate, its inner margin conspicuously and irregularly toothed.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, December 31, 1930 (*Clagg*); holotype, male; allotype, female; paratypes, 2 males.

Among the described regional species of the subgenus, *Limonia (Geranomyia) immobilis* seems to be most closely allied to *L.* (*G.*) *suensoniana* Alexander (eastern China), agreeing in the chief features of wing venation, as the long Sc and position of m-cu, differing in the distribution of the brown areas of the wing, especially along the posterior margin, and very conspicuously in the details of structure of the male hypopygium.

HEXATOMINI

ATARBA (ATARBODES) APOENSIS sp. nov. Plate 1, fig. 9; Plate 3, fig. 32.

General coloration of mesonotum yellowish brown; pleura yellow, the pteropleurite conspicuously blackened; antennal flagellum pale brown; legs yellow; wings yellow, the anterior branch of Rs subequal in length to Rs, diverging strongly from the posterior branch; male hypopygium with the lateral spines of the outer dististyle erect and strongly curved; ædeagus deeply trifid at apex.

Male.—Length, about 3.5 millimeters; wing, 4 to 4.2.

Rostrum and basal segments of palpi yellow, the outer palpal segments blackened. Antennæ with the scape and pedicel obscure yellow; flagellum pale brown; flagellar segments cylindrical, becoming more elongate outwardly; verticils of basal segments much exceeding the segments in length. Head brown.

Mesonotal præscutum yellowish brown, darker near the suture; posterior sclerites of mesonotum pale brown. Pleura yellow, with a conspicuous black spot on the pteropleurite. Halteres yellow. Legs with the coxæ and trochanters yellow; remainder of legs light yellow, only the terminal tarsal segments infuscated. Wings (Plate 1, fig. 9) light yellow, the costal region slightly more saturated; veins yellow. Macrotrichia of veins relatively sparse, there being none on either the first or second section of vein M_{1+2} and only one or two at extreme outer end of Rs. Venation: Sc_1 ending about opposite one-fourth the length of Rs; anterior branch of Rs short, diverging widely from the posterior branch, subequal in length to Rs; cell R_2 at margin about one-third as extensive as cell R_4.

Abdomen, including hypopygium, yellow; lateral margins of segments infuscated; in male, a blackened ring on segments eight and nine. Male hypopygium (Plate 3, fig. 32) with the basistyle, *b*, unarmed with tubercles. Outer dististyle, *od*, entirely blackened, the outer margin with five or six powerful, erect, curved spines, the apex of style broadly flattened and produced into many acute teeth and spines of various sizes. Ædeagus, *a*, relatively short, deeply trifid, the ends of the three arms a little expanded and truncated.

MINDANAO, Davao, district, Calian, Mount Apo, Baroring River (*Clagg*); holotype, male, altitude 6,000 feet, November 10, 1930; paratypes, 2 males, altitude 7,000 feet, November 8 and 9, 1930.

Atarba (*Atarbodes*) *apoensis* is very distinct from all regional species of the genus. The group of Formosan and Japanese *Atarbodes* have the venation of the radial field entirely different, the branches of Rs extending generally parallel to one another to the margin, cells R_2 and R_4 at margin being subequal or with R_2 more extensive than cell R_4. In venation, the present species is closer to *A.* (*A.*) *argentata* Edwards (Federated Malay States) which has a somewhat similar arrangement of wing veins in the radial field but a very different hypopygium. The deeply trifid ædeagus of *apoensis* is very different from the condition existing in the other regional species known to me. The condition is suggested in *A.* (*A.*) *fuscicornis* Edwards (Formosa), but in the present species the incisions are much deeper. In the single genus *Atarba*, species occur that have the ædeagus simple, profoundly bifurcate, and deeply trifurcate, an unusual range to occur within the limits of a single restricted group. The genus and subgenus are new to the Philippine fauna.

ERIOCERA (ERIOCERA) VITTULA sp. nov. Plate 1, fig. 10.

Allied to *vittipennis;* mesonotum light gray, the præscutum with four black stripes; antennal flagellum and legs chiefly obscure yellow; wings whitish, heavily streaked with brown, the latter color appearing as darkened seams to the veins.

Female.—Length, about 19 millimeters; wing, 14.

Rostrum black, gray pruinose; palpi brownish black. Antennæ with the scape light gray; pedicel and basal four segments of flagellum yellow, the outer four or five segments brown. Head light gray, with long coarse black setæ.

Pronotum dark gray. Mesonotum light gray, the præscutum with four conspicuous black stripes, the intermediate pair separated by a space more than one-half as wide as the stripe itself; lateral stripes nearly one-half as long as the intermediates, not crossing the suture; scutum gray, conspicuously marked with black; scutellum chiefly black, the caudal margin and a capillary median vitta more grayish; postnotum gray. Pleura gray, variegated with blackish. Halteres blackened. Legs with coxæ gray; trochanters brownish black; femora and tibiæ obscure yellow, very narrowly tipped with dark brown; all tarsal segments obscure yellow, the tips narrowly darkened; legs conspicuously hairy. Wings (Plate 1, fig. 10) with the ground color whitish, the veins conspicuously bordered with dark brown to produce a streaked appearance, almost as in *vittipennis.* Costal fringe abundant and conspicuous. Venation: Humeral crossvein oblique; R_2 oblique, directed basad, subequal to or shorter than R_{2+3}; basal section of R_5 about one-half Rs.

Abdominal tergites blackened medially, the basal lateral portions of the individual segments heavily light gray pruinose; rufous-orange areas on sides of segments two and three before the caudal margin; basal sternites yellow, the outer segments gray, margined caudally with dark brown; ovipositor with the genital shield deep orange, the elongate valves orange-horn colored.

MINDANAO, Davao district, Calian, Mount Apo, Galog River trail, altitude 5,000 to 6,000 feet, November 13, 1930 (*Clagg*); holotype, female.

Although this fly is closely allied to *Eriocera vittipennis* Alexander (Mindanao), I must regard it as being distinct, differing in the larger size, the more-extensive yellow coloration of the antennal flagellum, the obscure yellow femora and tibiæ, and the details of venation, especially the position of R_2 and the greater

depth of the radial cells. The venation of *vittipennis* is shown (Plate 1, fig. 11) for comparison.

ERIOCERA (ERIOCERA) DIGNITOSA sp. nov. Plate 1, fig. 12.

Male.—Length, about 22 millimeters; wing, 23.5.

Very closely allied to *E. mindanaoensis* Alexander (Mindanao, Bukidnon Subprovince), differing especially in the larger size and details of venation.

Legs black. Wings (Plate 1, fig. 12) strongly suffused with dark brown, more intense than in *mindanaoensis*, especially in the costal region. Costal fringe very short but dense. Venation: Humeral crossvein transverse; R_{2+3+4} long, exceeding one-half of Rs. *Eriocera mindanaoensis* has R_{2+3+4} about two-fifths the length of Rs (Plate 1, fig. 13).

MINDANAO, Davao district, Calian, Sibulan Barrio, altitude 2,000 feet, October 8, 1930 (*Clagg*) holotype, male.

Genus GONOMYIA Meigen

Gonomyia MEIGEN, Syst. Beschreib. Europ. Dipt. 1 (1818) 146.
Goniomyia OSTEN SACKEN, Mon. Dipt. North America 4 (1869) 177.

The rather numerous species of *Gonomyia* now known from the Philippines fall in five subgenera, the largest being *Lipophleps*. The following key to these species is based essentially on male characters.

Key to the Philippine species of Gonomyia Meigen.

1. Cell R_1 of wings lacking .... 2.
   Cell R_1 of wings present .... 14.
2. Cell 1st M_2 open by atrophy of basal section of M_3, cell 2d M_2 very small; antennal verticils (male) short. (Subgenus *Ptilostenodes* Alexander.) (Luzon.) .... *ptilostenella* Alexander.
   Cell 1st M_2 closed; antennal verticils (male) long and conspicuous. (Subgenus *Lipophleps* Bergroth, partim.) .... 3.
3. Wings with Sc long, Sc_1 ending opposite from one-third to two-fifths the length of Rs (*skusei* group) .... 4.
   Wings with Sc short, Sc_1 ending opposite or before the origin of Rs.. 7.
4. Male hypopygium with two dististyles, the outer a very long, slender, chitinized rod. (Mindanao.) .... *sagittifera* Alexander.
   Male hypopygium with a single, entirely fleshy dististyle .... 5.
5. Male hypopygium with the ædeagus dilated and bearing a comblike row of small chitinized spines. (Mindanao.)
   acanthophallus Alexander.
   Male hypopygium without such armature of the ædeagus .... 6.
6. Male hypopygium with the dististyle and outer lobe of basistyle relatively short and stout, less than one-half the length of the remainder of basistyle; phallosome terminating in five free points. (Luzon.)
   longiradialis Alexander.

Male hypopygium with the dististyle and outer lobe of basistyle long and slender, subequal in length to the remainder of basistyle; phallosome compact, without free blackened points. (Mindanao.) *macilenta* sp. nov.

7. Wings unmarked, except for the stigmal area when this is present.... 8.
Wings spotted or clouded with darker areas, in addition to the stigmal spot .... 11.

8. Legs uniformly dark brown; male hypopygium with a single, subterminal dististyle .... 9.
Legs pale, the femora with a conspicuous black terminal or subterminal ring; male hypopygium with three dististyles that are terminal in position, or nearly so .... 10.

9. Male hypopygium with the dististyle heavily sclerotized and blackened, unequally bispinous. (Luzon; British India to Japan.) *incompleta* Brunetti.
Male hypopygium with the outer dististyle small, simple, entirely fleshy. (Luzon.) .... *maquilingia* Alexander.

10. Male hypopygium with the outer dististyle simple; innermost dististyle produced into three acute blackened points. (Mindanao and Luzon.) *alboannulata* Alexander.
Male hypopygium with the outer dististyle unequally bifid; innermost dististyle simple, entirely pale. (Mindanao.)........ *discreta* sp. nov.

11. Wings with three major dark costal areas, placed at origin of Rs, at stigma, and at tip of R_{1+2}; male hypopygium with three dististyles, all simple, the innermost shortest and entirely pale. (Mindanao.) .... *tristigmata* sp. nov.
Wings not patterned as above; male hypopygium with two dististyles; or when with three (*bicolorata*), the outermost style branched on basal half, the innermost nearly as long, at apex drawn out into a long straight spine .... 12.

12. Wings heavily and almost uniformly clouded with brown, the costal region conspicuously pale; Sc very short, Sc_1 ending nearly its own length before the origin of Rs; male hypopygium with three dististyles. (Luzon.) .... *bicolorata* Alexander.
Wings not so patterned, the darkened areas appearing as spots or seams along cord; Sc_1 ending only a short distance before origin of Rs; male hypopygium with two dististyles........ 13.

13. Wings with a conspicuous dark pattern, including a major area at near midlength of cell R, in addition to the usual clouding along the cord, the dark pattern about as deep and intense as the stigmal area; male hypopygium with the outer dististyle a powerful blackened rod, bifid at extreme tip, inner dististyle entirely pale. (Luzon.) .... *secreta* Alexander.
Wing pattern very diffuse, appearing as scarcely indicated darkenings along cord and elsewhere on wing disk, this pattern much paler than the stigmal area; male hypopygium with the outer dististyle slender, bearing an acute spine on basal third; apex of inner dististyle an erect to slightly recurved black spine. (Mindanao.) *luteimarginata* Alexander.

14. Cell R_1 of wings very small, vein R_2 nearly perpendicular; cell R_2 at margin fully as wide as cell R_3. (Subgenus *Lipophleps* Bergroth, partim.) (Luzon.) .... *pallidisignata* Alexander.
 Cell R_2 very extensive, at wing margin fully three or four times as wide as cell R_1.. 15.
15. Cell 1st M_2 closed. (Subgenus *Gonomyia* Meigen.) (Mindanao.) *nebulicola* sp. nov.
 Cell 1st M_2 open by atrophy of basal section of M_3.................................. 16.
16. Wings with m-cu at or beyond the fork of M. (Subgenus *Progonomyia* Alexander.) (Mindanao.) .... *terebrella* Alexander.
 Wings with m-cu more than its own length before the fork of M. (Subgenus *Ptilostena* Bergroth.).. 17.
17. Wings unmarked, except for the stigmal area; Sc short, Sc_1 ending opposite origin of Rs; cell R_2 small, on margin shorter than cell R_4 and only a little more extensive than cell R_2. (Negros and Java.) *metatarsata* de Meijere.
 Wings spotted with brown, including areas at origin of Rs, tip of vein R_4, and along cord; Sc longer, Sc_1 ending about opposite one-third the length of Rs; cell R_2 on margin very extensive, much exceeding cell R_4; cell R_1 almost closed on margin by approximation of veins R_{1+2} and R_3. (Mindanao, Buru, and North Borneo.) *punctipennis* Edwards.

The various references given herewith in conjunction with the different species of *Gonomyia* (and also of the genera *Erioptera* and *Molophilus*, later in this same report) pertain to exact distributional records for the Philippines rather than to the original descriptions of the various species.

PHILIPPINE SPECIES OF THE SUBGENUS PTILOSTENODES

Ptilostenodes Alexander.[8] One Philippine species.

Gonomyia (*Ptilostenodes*) *ptilostenella* Alexander; ALEXANDER, Philippines, IX, Philip. Journ. Sci. 45 (1931) 441–442.

The various species of *Ptilostenodes* are all Oriental, ranging from Formosa to Java.

PHILIPPINE SPECIES OF THE SUBGENUS LIPOPHLEPS

Lipophleps Bergroth. The numerous species of this subgenus in the Philippines are not safely to be determined except by a careful study of the male genitalic characters, which here offer unusually strong characters for the separation of otherwise similar species.

Gonomyia (*Lipophleps*) *acanthophallus* Alexander; ALEXANDER, Philippines, IX, Philip. Journ. Sci. 45 (1931) 442–443.

[8] Arch. für Hydrobiol., Suppl. Bd. 9 (1931) 182.

Gonomyia (*Lipophleps*) *alboannulata* Alexander; ALEXANDER, Philippines, X, Philip. Journ. Sci. 46 (1931) 31–32.

Gonomyia (*Lipophleps*) *bicolorata* Alexander; ALEXANDER, Philippines, VII, Philip. Journ. Sci. 43 (1930) 295–297.

Gonomyia (*Lipophleps*) *discreta* sp. nov.; this report.

Gonomyia (*Lipophleps*) *incompleta* Brunetti; ALEXANDER, Philippines, X, Philip. Journ. Sci. 46 (1931) 29–30.

Gonomyia (*Lipophleps*) *longiradialis* Alexander; ALEXANDER, Philippines, VI, Philip. Journ. Sci. 41 (1930) 307–308.

Gonomyia (*Lipophleps*) *luteimarginata* Alexander; ALEXANDER, Philippines, X, Philip. Journ. Sci. 46 (1931) 32–33.

Gonomyia (*Lipophleps*) *macilenta* sp. nov.; this report.

Gonomyia (*Lipophleps*) *maquilingia* Alexander; ALEXANDER, Philippines, X, Philip. Journ. Sci. 46 (1931) 28–29.

Gonomyia (*Lipophleps*) *pallidisignata* Alexander; ALEXANDER, Philippines, X, Philip. Journ. Sci. 46 (1931) 30–31.

Gonomyia (*Lipophleps*) *sagittifera* Alexander; ALEXANDER, Philippines, XIV, Philip. Journ. Sci. 48 (1932) 40–41.

Gonomyia (*Lipophleps*) *secreta* Alexander; ALEXANDER, Philippines, X, Philip. Journ. Sci. 46 (1931) 33–34.

Gonomyia (*Lipophleps*) *tristigmata* sp. nov.; this report.

Species of *Lipophleps* abound in most of the faunal areas of the world, excepting the western Palæarctic, being very characteristic of the Oriental and Neotropical Regions, and of the remote islands of the Pacific Ocean.

PHILIPPINE SPECIES OF THE SUBGENUS GONOMYIA

Gonomyia Meigen, s. s. A single species of this widely distributed subgenus has been taken in the Philippines but others will certainly be found to occur there.

Gonomyia (*Gonomyia*) *nebulicola* sp. nov.; this report.

The subgenus is the dominant one in the entire Holarctic Region, with relatively fewer species in the Neotropical, Ethiopian, and Oriental Regions.

PHILIPPINE SPECIES OF THE SUBGENUS PROGONOMYIA

Progonomyia Alexander. As is the case with the last group, a single species has been described from the Philippines but others must exist in this diversified region.

Gonomyia (*Progonomyia*) *terebrella* Alexander; ALEXANDER, Philippines, XI, Philip. Journ. Sci. 46 (1931) 285–286.

The majority of the species of this subgenus occur in the Neotropical and southern Ethiopian Regions, with a few species in the Oriental Region and southern parts of the eastern Palæarctic Region.

PHILIPPINE SPECIES OF THE SUBGENUS PTILOSTENA

Ptilostena Bergroth. Two widely-distributed lowland species have been discovered in the Philippines.

Gonomyia (Ptilostena) metatarsata de Meijere; EDWARDS, Notulae Entomologicae 6 (1926) 37.

Gonomyia (Ptilostena) punctipennis Edwards; ALEXANDER, Philippines, X, Philip. Journ. Sci. 46 (1931) 35.

The subgenus is very characteristic of the Holarctic Region, with a few scattered species in the Ethiopian, Oriental, and Australasian Regions.

GONOMYIA (LIPOPHLEPS) MACILENTA sp. nov. Plate 1, fig. 14; Plate 3, fig. 33.

Belongs to the *skusei* group; general coloration of mesonotum dark brown, the scutellum and cephalic-lateral portions of the postnotal mediotergite yellow; pleura dark brown, with a conspicuous whitish longitudinal stripe; apices of knobs of halteres yellow; legs brownish black; wings with a brownish tinge, the stigma a little darker; Sc_1 ending about opposite two-fifths the length of Rs; male hypopygium with a single dististyle, this subequal in length to the outer lobe of basistyle.

Male.—Length, about 3.3 to 3.5 millimeters; wings, 3.8 to 4.

Rostrum obscure yellow; palpi black. Antennæ black throughout; flagellar segments elongate, with an abundant elongate white pubescence. Head black, gray pruinose, the central portion of the posterior vertex light yellow.

Pronotum and anterior lateral pretergites light yellow. Mesonotum dark brown, the median region of scutum a trifle paler; scutellum chiefly testaceous-yellow; cephalic-lateral angles of postnotal mediotergite yellow. Pleura dark brown, with a conspicuous whitish longitudinal stripe crossing the ventral sclerites. Halteres dusky, the base of stem and apex of knob light yellow. Legs with the fore coxæ pale, the remaining coxæ and all trochanters darkened; remainder of legs brownish black. Wings (Plate 1, fig. 14) with a brownish tinge, the stigmal region darker brown; veins pale brown. Macrotrichia on more than distal half of vein 1st A and on distal fifth of 2d A. Venation: Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 about halfway between origin of Rs and tip of Sc_1; basal section of R_5 short, r-m correspondingly lengthened, gently arcuated; m-cu shortly before fork of M.

Abdominal tergites dark brown, the sternites paler. Male hypopygium (Plate 3, fig. 33) with the outer angle of basistyle,

b, prolonged into a slender lobe. A single dististyle, *d*, that is about as long as the lobe of the basistyle, a little dilated on outer half, terminating in a powerful fasciculate seta, with several smaller setæ on distal half, including one of unusual length on outer face at near three-fourths the length of style. Phallosome, *p*, compact, without free blackened points, as is the case in *longiradialis*, or without a series of acute spines, as in *acanthophallus;* apex of longest lobe ending in a short acute point, provided with several microscopic setulæ.

MINDANAO, Davao district, Mati, Mount Mayo, altitude 5,000 feet, January 29, 1931 (*Clagg*); holotype, male; paratype, male.

Gonomyia (*Lipophleps*) *macilenta* is most nearly allied to *G.* (*L.*) *acanthophallus* Alexander (Mindanao) in its general appearance and venation, differing conspicuously in the structure of the male hypopygium, more especially of the phallosome.

GONOMYIA (LIPOPHLEPS) DISCRETA sp. nov. Plate 1, fig. 15; Plate 3, fig. 34.

General coloration dark brown; thoracic pleura striped longitudinally with dark brown and silvery white; halteres with the knobs dark, the outer third obscure yellow; femora with a dark subterminal ring; wings nearly hyaline, unmarked; male hypopygium with three dististyles, the outer stout, blackened, forked at beyond midlength; middle dististyle a pale tail-like setiferous lobe.

Male.—Length, about 2.8 to 3 millimeters; wing, 3.

Female.—Length, about 4 millimeters; wings, 4.

Rostrum and palpi black. Antennæ with the basal segments light brown, the succeeding three or four segments pale, the outer ones passing to black; flagellar verticils very long. Head badly flexed, apparently uniformly dark gray.

Mesonotum dark brown, the anterior lateral pretergites light yellow; posterior sclerites of mesonotum concealed by mounting medium, the pleurotergite obscure yellow. Pleura chiefly obscure yellow, with a conspicuous longitudinal silvery stripe across the ventral sclerites, this area bordered dorsally and less evidently on ventral edge by brown lines, the more dorsal extending from the propleura to the base of abdomen, passing beneath the halteres; ventral sternopleurite dark brown, pruinose. Halteres yellow, the basal two-thirds of the knob infuscated, the apex restrictedly yellow in male, entirely dark in female. Legs with the fore coxæ narrowly darkened; remaining coxæ and all trochanters pale yellow; femora pale brown, with a darker brown subterminal ring that is preceded and followed by clear

yellow annuli; tibiæ and tarsi pale, the tips of basitarsi and remaining tarsal segments dark brown. Wings (Plate 1, fig. 15) nearly hyaline, the stigma not or scarcely evident; veins pale brown. Costal fringe relatively long and conspicuous; macrotrichia on outer ends of both anal veins. Venation: Sc of moderate length, Sc_1 ending just before origin of Rs, Sc_2 not evident; anterior branch of Rs gently sinuous; m-cu before fork of M; vein 2d A nearly straight to gently convex.

Abdomen chiefly dark brown, the pleural region broadly silvery white; hypopygium dark. In female, caudal margins of tergites narrowly pale yellow. Male hypopygium (Plate 3, fig. 34) with the outer dististyle, *od*, a powerful blackened rod, at just beyond midlength bifid, the outer arm a slender, gently curved spine that narrows to an acute point; inner arm a blunt structure, densely set with obtuse teeth to produce a macelike appearance; besides these small, compact denticles, there is a single outstanding spine. Middle dististyle, *md*, an elongate pale rod, a little expanded on outer half, thence narrowed to a slender apical point, the margin with numerous setæ. Inner dististyle, *id*, shortest, exceeding one-half the middle style, with numerous setæ, including a fasciculate seta near apex.

MINDANAO, Davao district, Libby, December 9, 1930 (*Clagg*); holotype, male; allotype, female; paratype, female.

Gonomyia (*Lipophleps*) *discreta* is very different from other regional species in the structure of the male hypopygium, especially of the outer and middle dististyles. By Edwards's key to the Oriental species of *Lipophleps* [9] the present fly runs out at couplet 4, disagreeing with both included species in the coloration of the body. The structure of the male hypopygium of *G.* (*L.*) *diffusa* (de Meijere) has not been described and is not known to me.

GONOMYIA (LIPOPHLEPS) TRISTIGMATA sp. nov. Plate 1, fig. 16; Plate 3, fig. 35.

General coloration brownish gray; scutellum obscure yellow; pleura chiefly brown, with a conspicuous silvery longitudinal stripe; halteres yellow, the basal half of knob brown; legs chiefly dark brown; wings weakly darkened, the costal region broadly pale, variegated by three large brown spots; male hypopygium with three dististyles.

Male.—Length, about 2.6 to 2.7 millimeters; wing, 3 to 3.2.

Female.—Length, about 3.6 to 3.8 millimeters; wing, 3.8.

[9] Journ. Federated Malay States Mus. 14 (1928) 104–105.

Rostrum and palpi black. Antennæ with the scape yellow above, infuscated on lower face; pedicel yellow; flagellum dark brown. Head chiefly yellow above, darker in the male.

Mesonotum brownish gray, the anterior lateral pretergites very pale yellow; pseudosutural foveæ black; posterior sclerites of mesonotum dark, the scutellum obscure yellow. Pleura with the dorsal region pale brown, the ventral portion chiefly occupied by a conspicuous longitudinal silvery stripe that is bordered both dorsally and ventrally by dark brown. Halteres pale yellow, the basal half of knob brown. Legs with the fore coxæ silvery white, the remaining coxæ and all trochanters brownish testaceous to brown; remainder of legs dark brown, in cases with the extreme tip of femur slightly paler. Wings (Plate 1, fig. 16) with the ground color weakly infuscated, the costal region broadly pale yellow, variegated by three large brown spots, the first placed at tip of Sc and origin of Rs; the second, stigmal, at end of R_1; the last at outer end of anterior branch of Rs; a further paler brown wash in the arcular region; remainder of ground color more or less variegated by slightly darker seams along cord and outer end of cell 1st M_2. Costal fringe (male) long and conspicuous; vein 1st A without macrotrichia; vein 2d A with only one or two near outer end. Venation: Sc_1 ending about opposite or just beyond origin of Rs; basal section of R_5 long, exceeding m; m-cu just before fork of M; vein 2d A gently sinuous.

Abdominal tergites brown, variegated at caudal-lateral angles by obscure yellow, the caudal margins more narrowly pale; sternites brown, the caudal margins pale; hypopygium chiefly dark colored. Male hypopygium (Plate 3, fig. 35) with three dististyles, the outer, *od*, longest, a slender blackened rod that is narrowed to a nearly acute tip, at near midlength on inner face, with an expanded darkened flange. Second style, *md*, a simple rod that is about two-thirds the length of the first, narrowed to an acute point, the distal half blackened. Inner style, *id*, a slender fingerlike pale lobe, the outer half with several punctures, at apex with two fasciculate setæ. Phallosome, *p*, consisting of two slender, gently diverging rods, the tips acute. Ædeagus at apex curved into a crook.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet (*Clagg*); holotype, male, January 1, 1931; allotype, female, December 29, 1930; paratypes, 5 males and females, December 29, 1930 to January 1, 1931.

Gonomyia (*Lipophleps*) *tristigmata* is readily distinguished by the conspicuous wing pattern and the structure of the male hypopygium. By Edwards's key to the Oriental species of the subgenus [10] the present fly runs to *G.* (*L.*) *hackeri* Edwards, which has a very different male hypopygium.

GONOMYIA (GONOMYIA) NEBULICOLA sp. nov. Plate 1, fig. 17; Plate 3, fig. 36.

General coloration of mesonotum brownish gray, the scutellum yellow; rostrum obscure yellow, antennæ black throughout; pleura yellow, variegated with brown; knobs of halteres slightly brightened; legs black; wings nearly hyaline, the stigma a trifle darker; Sc_1 ending shortly beyond origin of Rs; R_{2+3+4} strongly arcuated; basal section of R_5 short; male hypopygium with the inner dististyle trifid; phallosome asymmetrical.

Male.—Length, about 4 millimeters; wing, 4.5.

Female.—Length, about 5 millimeters; wing, 4.7 to 4.8.

Rostrum obscure yellow; palpi black. Antennæ black throughout; flagellar segments long-oval, decreasing in size outwardly. Head light gray.

Pronotum and anterior lateral pretergites yellow. Mesonotum brownish gray, the humeral region of præscutum restrictedly obscure yellow; pseudosutural foveæ black; median region of scutum and the broad scutellum obscure yellow. Pleura obscure yellow, variegated on anepisternum with dark brown, on the ventral sternopleurite with reddish brown. Halteres dusky, the base of stem and apex of knobs a little brighter. Legs with the fore coxæ weakly darkened, the remaining coxæ more yellow; trochanters brownish yellow; remainder of legs black. Wings (Plate 1, fig. 17) nearly hyaline, the oval stigma a little darker than the ground color; veins brownish black. Costal fringe relatively long and conspicuous. Venation: Sc_1 ending shortly beyond origin of Rs, in cases to opposite one-fifth the length of the latter vein; Sc_2 not far from tip of Sc_1; R_{2+3+4} strongly arcuated; basal section of R_5 short, r-m correspondingly lengthened; m-cu at or very close to fork of M.

Abdominal tergites dark brown, the sternites more yellowish brown; hypopygium dark. Male hypopygium (Plate 3, fig. 36) with the basistyle, *b*, relatively long and slender, with a short apical lobe. Outer dististyle, *od*, fleshy, setiferous. Inner dististyle, *id*, trifid, its outermost arm a strongly curved spine, the central portion a more nearly straight spine; outer portion of

[10] Loc. cit.

inner dististyle with conspicuous setæ. Phallosome, *p*, asymmetrical, the ædeagus being subtended by one long black sinuous spine.

MINDANAO, Davao district, Calian, Mount Apo, Galog River, altitude 6,000 feet, October 16, 1930 (*Clagg*); holotype, male; allotype, female, October 18, 1930; paratypes, several of both sexes, chiefly females, altitude 6,000 feet, September 18, October 10, 12, 16, and 25, November 3 and 4, 1930; 1 male, 1 female, La Lun Mountains, altitude 5,500 feet, December 31, 1930, and January 1, 1931; 1 male, Mount Mayo, altitude 4,000 feet, January 26, 1931.

Gonomyia (*Gonomyia*) *nebulicola* is the first species of the subgenus to be recorded from the Philippines. It is distinguished from *G.* (*G.*) *affinis* Brunetti (British India) and *G.* (*G.*) *bryanti* Alexander (Java) by the strongly arcuate R_{2+3+4}. It is further distinguished from *bryanti* by the structure of the inner dististyle of the male hypopygium, and from the Bornean *G.* (*G.*) *symmetrica* Edwards, by the very different male hypopygium.

Genus ERIOPTERA Meigen

Erioptera MEIGEN, Illiger's Magaz. 2 (1803) 262.

The various Philippine species of *Erioptera* may be separated by means of the following key, which is based in part on male characters.

Key to the Philippine species of Erioptera Meigen.

1\. Cell R_3 relatively shallow, vein R_2 lying far before its inner end, vein R_{3+4} thus being present as a distinct element. (Subgenus *Empeda* Osten Sacken.) .... 2.

Cell R_3 deep, vein R_2 connecting with R_{2+3} beyond the inner end of cell R_3, vein R_{2+3} thus being present as a distinct element .... 4.

2\. Femora uniformly darkened on distal half or more; general coloration of mesonotum light brown, paling to gray on sides. (Mindanao.) .... *lunensis* Alexander.

Femora yellow, narrowly and abruptly tipped with black; general coloration of thorax black .... 3.

3\. Humeral region of præscutum with a conspicuous yellow triangular area; R_{3+4} longer than R_4; male hypopygium with the outer dististyle blackened, the arms slender. (Mindanao.) .... *rata* sp. nov.

Mesonotal præscutum uniformly blackened; R_{3+4} shorter than R_4; male hypopygium with the outer dististyle entirely pale, the arms expanded at outer ends. (Mindanao.) .... *perrata* sp. nov.

4\. Cell 1st M_2 closed. (Subgenus *Ilisia* Rondani.) .... 5.

Cell 1st M_2 open by the atrophy of m .... 6.

5. General coloration of thorax gray, variegated with velvety black, especially on lateral portions; femora chiefly darkened, ringed with yellow, the extreme tip pale; wings pale, with an ocellate dark pattern, the numerous marginal areas paler medially, bordered with brown; vein Sc_2 just before the fork of Rs. (Oriental Region; Mindanao.) .... *fenestrata* (re Meijere).
   General coloration of thorax reddish yellow, the posterior sclerites of mesonotum and a dorsal stripe on pleura dark brown; legs yellow, the tips of femora narrowly to insensibly darkened; wings pale, with a more-restricted, solidly darkened pattern; Sc_2 just beyond origin of Rs. (Mindanao.) .... *perpictula* Alexander.
6. Apical cells of wing very deep, the cord lying at or before midlength of wing; vein 2d A only slightly sinuous. (Subgenus *Teleneura* Alexander.) .... 7.
   Apical cells of wing shallower, the cord lying at from three-fifths to two-thirds the length of wing; vein 2d A very strongly sinuous, with nearly the distal half extending parallel to caudal margin of wing. (Subgenus *Erioptera* Meigen.) .... 9.
7. Wings with a heavy, pale brown pattern; femora with about the basal half darkened, the apical portion broadly light yellow. (Oriental Region; Mindanao.) .... *nigribasis* Edwards.
   Wings uniformly suffused with darker, immaculate; legs uniformly darkened .... 8.
8. General coloration of præscutum dark brown to black, the thoracic pleura concolorous. (Oriental Region; Mindanao.) *fusca* de Meijere.
   General coloration of præscutum light brown, paling to yellow on margins; thoracic pleura with a conspicuous, brownish black, longitudinal stripe. (Mindanao and Luzon.) .... *melanotænia* Alexander.
9. Wings with a saturated grayish yellow suffusion, the costal cell whitish; no darkened seam along cord; some of veins narrowly bordered with yellow. (Luzon.) .... *rubripes* Alexander.
   Wings pale, with a faint infuscate cloud along cord, darkening the veins and adjoining membrane; no brightening of membrane adjoining the veins .... 10.
10. Male hypopygium with the outer dististyle bifid, its outer arm an acute spine, the inner arm a rounded capitate head. (Philippines.) *luzonica* Alexander.
    Male hypopygium with the outer dististyle a simple, blackened rod.. 11.
11. Male hypopygium with the inner dististyle a flattened, oval blade bearing an acute spine on outer margin; gonapophyses obtuse and weakly bifid at tips. (Mindanao.) .... *lunicola* sp. nov.
    Male hypopygium with the inner dististyle a slender rod, without spines, at apex dilated into a weak head; gonapophyses appearing as acute spines. (Mindanao.) .... *alta* sp. nov.

PHILIPPINE SPECIES OF THE SUBGENUS EMPEDA

Empeda Osten Sacken. Besides the two species described herewith, a single species had been recorded from the Philip-

pines. Species of this subgenus will surely be found to occur in the mountains of Luzon.

Erioptera (Empeda) lunensis Alexander; ALEXANDER, Philippines, XI, Philip. Journ. Sci. 46 (1931) 288–289.

Most of the species of *Empeda* occur in the Holarctic and northern Neotropical and Oriental Regions. A very few others are found in the Ethiopian and Australasian Regions.

PHILIPPINE SPECIES OF THE SUBGENUS ILISIA

Ilisia Rondani. I am very doubtful as to whether *perpictula* can be correctly referred to this subgenus, since the male hypopygium is very different from that of the typical form. *Erioptera fenestrata* is a perfectly typical member of *Ilisia.*

Erioptera (Ilisia) fenestrata (de Meijere); this report.
Erioptera (Ilisia) perpictula Alexander; ALEXANDER, Philippines, IX, Philip. Journ. Sci. 45 (1931) 443–444.

The species of *Ilisia* are all Holarctic, with the exception of a few species occurring in Formosa and the Malayan islands.

PHILIPPINE SPECIES OF THE SUBGENUS TELENEURA

Teleneura Alexander. Three species are now known from the Islands.

Erioptera (Teleneura) nigribasis Edwards; this report.
Erioptera (Teleneura) fusca de Meijere; ALEXANDER, Philippines, XI, Philip. Journ. Sci. 46 (1931) 287.
Erioptera (Teleneura) melanotaenia Alexander; ALEXANDER, Philippines, XI, Philip. Journ. Sci. 46 (1931) 287–288.

All known species of the subgenus are Oriental.

PHILIPPINE SPECIES OF THE SUBGENUS ERIOPTERA

Erioptera Meigen, s. s. To the four species recorded herewith, numerous additions will probably be made as further collections are taken in the mountains of the major islands of the group.

Erioptera (Erioptera) alta sp. nov.; this report.
Erioptera (Erioptera) lunicola sp. nov.; this report.
Erioptera (Erioptera) luzonica Alexander; this report.
Erioptera (Erioptera) rubripes Alexander; ALEXANDER, Philippines, VIII, Philip. Journ. Sci. 45 (1931) 287–288.

Species of the typical subgenus *Erioptera* are found in all major regions of the World.

ERIOPTERA (EMPEDA) RATA sp. nov. Plate 3, fig. 38.

Mesonotal præscutum almost covered by three confluent black stripes, leaving the humeral region obscure yellow; tips of femora narrowly blackened; wings grayish subhyaline, the stigma distinct; male hypopygium with the outer dististyle heavily blackened, the arms slender.

Male.—Length, about 3 millimeters; wing, 4.

Female.—Length, about 3.5 millimeters; wing, 4.

Rostrum dark; palpi chiefly yellowish brown. Antennæ with the scape and pedicel black; flagellar segments pale brown, the outer segments darker; flagellar segments subglobular to short-oval, the outer segments more elongate-oval; verticils of moderate length only. Head light gray.

Pronotum and anterior lateral pretergites yellow. Mesonotal præscutum almost covered by three, confluent, shiny, black stripes, only the humeral triangles reddish yellow; scutum black, a trifle pruinose; scutellum grayish black basally, the margin obscure reddish; postnotal mediotergite black, sparsely pruinose. Pleura yellow, conspicuously variegated with dark gray, the latter areas including the anepisternum, ventral sternopleurite, and most of the pleurotergite; dorsopleural region and ventral sternopleurite of the ground color. Halteres yellow. Legs with the fore coxæ brownish black; remaining coxæ and trochanters yellow; femora, tibiæ, and basitarsi yellow, the tips narrowly but conspicuously blackened; remainder of tarsi black. Wings grayish subhyaline, the prearcular region and costal margin a trifle more yellowish; stigma pale brown but distinct; veins pale brown, paler in costal region. Venation: Sc_1 ending about opposite one-fifth the length of Rs; R_{3+4} longer than R_4.

Abdominal tergites dark brown; sternites yellow; hypopygium chiefly reddish brown. In female, the abdominal tergites, especially the outer ones, narrowly ringed caudally with obscure yellow. Male hypopygium (Plate 3, fig. 38) with the outer dististyle, *od*, entirely blackened, both arms slender, subequal to or a trifle longer than the stem. Inner dististyle, *id*, dilated at outer end into a spatula that is provided with rather numerous setulæ.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, December 29, 1930 (*Clagg*); holotype, male; allotype, female.

Most nearly allied to *Erioptera* (*Empeda*) *nigroapicalis* Alexander (Formosa) in the large size, pattern of legs, and heavily

blackened dististyles of the male hypopygium, differing in the confluent black pattern of the mesonotal præscutum, the heavily darkened pleura, and details of the wing venation and pattern, especially the shorter apical forks and the distinct stigmal area. In its blackened thoracic pattern, the present fly is similar to *E.* (*E.*) *perrata* sp. nov., differing in the heavily blackened outer dististyle of the male hypopygium.

ERIOPTERA (EMPEDA) PERRATA sp. nov. Plate 1, fig. 18; Plate 3, fig. 39.

Male.—Length, about 2.3 millimeters; wing, 3.

Closely allied to *E.* (*E.*) *rata* sp. nov., differing especially in the small size, uniformly darkened thorax, and pale styli of the male hypopygium.

Palpi entirely black. Mesonotal præscutum entirely black, without brightening at the humeri; remainder of mesonotum black, sparsely pruinose, the caudal margin of scutellum a trifle brightened. Pleura brownish black, the dorsal sternopleurite somewhat more intense; dorsopleural region yellow. Wings (Plate 1, fig. 18) without an evident stigmal area. Venation: R_{3+4} longer than R_2 but shorter than R_4. Abdominal tergites dark brown, the sternites and hypopygium more yellowish. Male hypopygium (Plate 3, fig. 39) with the dististyles entirely pale, the outer, *od*, deeply divided, its inner arm a broadly flattened spatula. Inner dististyle, *id*, a flattened blade, gradually widened distally, the apex obtusely rounded, provided with a few microscopic setulæ.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, January 1, 1931 (*Clagg*); holotype, male; paratype, 1 broken specimen, sex uncertain; 1 male, Mount Apo, Galog River, altitude 6,000 feet, October 16, 1930 (*Clagg*).

The present fly is very similar to the Japanese and Formosan *Erioptera* (*Empeda*) *minuscula* Alexander, in the pale dististyles of the male hypopygium, in conjunction with the small size and leg pattern, differing most evidently in the uniformly blackened mesonotum.

ERIOPTERA (ILISIA) FENESTRATA (de Meijere). Plate 3, fig. 37.

Acyphona fenestrata DE MEIJERE, Tijd. voor Entomol. 56 (1913) 352–353, pl. 17, fig. 19 (wing).

Described from Java, later recorded by Edwards from the Malay Peninsula and Borneo. MINDANAO, Davao district, Calian, Mount Apo, altitude 6,000 feet, October 16 to November 3, 1930 (*Clagg*); several of both sexes.

The distinctive male hypopygium (Plate 3, fig. 37) has not been described hitherto. Outer dististyle, *od*, unusually slender. Ædeagus short, subtended by the blackened horns of the gonapophyses, *g*.

ERIOPTERA (TELENEURA) NIGRIBASIS Edwards.

Erioptera nigribasis EDWARDS, Journ. Federated Malay States Mus. 14 (1928) 99–100, pl. 1, fig. 8 (wing).

Known hitherto only from Pahang and Borneo. MINDANAO, Davao district, Calian, Mount Apo, Sibulan River, altitude 5,000 to 6,000 feet, August 29 and October 18 to 20, 1930; Mainit River, altitude 6,000 feet, September 9, 1930 (*Clagg*).

ERIOPTERA (ERIOPTERA) LUZONICA Alexander.

Erioptera (*Erioptera*) *luzonica* ALEXANDER, Insec. Inscit. Menst. 5 (1917) 7–8.

Described from Luzon. Since taken at Badajoz, Tablas, August 28, 1928 (*Rivera and Duyag*). The fly is very closely allied to *E.* (*E.*) *notata* de Meijere,[11] differing especially in slight details of structure of the male hypopygium, notably of the outer dististyle and the gonapophyses.

ERIOPTERA (ERIOPTERA) ALTA sp. nov. Plate 1, fig. 19; Plate 3, fig. 40.

General coloration pale yellow, including the thoracic pleura; knobs of halteres weakly darkened; wings yellow, the veins of the cord darker; male hypopygium with the outer dististyle a little dilated on inner margin at near midlength; inner dististyle at apex expanded into a disklike head; gonapophyses appearing as blackened horns.

Male.—Length, about 3.5 to 4.5 millimeters; wing, 4 to 5.

Female.—Length, about 5 to 5.3 millimeters; wing, 6 to 6.2.

Rostrum pale brown, the palpi dusky. Antennæ with the scape and pedicel brown, the basal three or four segments of the flagellum light yellow; remaining flagellar segments brown, long-oval. Head yellow, the anterior vertex more whitish.

Anterior lateral pretergites whitish. Mesonotum yellow, the pseudosutural foveæ and tuberculate pits pale. Pleura pale yellow. Halteres yellow, the knobs weakly infuscated. Legs with the coxæ and trochanters pale yellow; remainder of legs yellow, the outer tarsal segments darkened. Wings (Plate 1, fig. 19) yellow, including the veins; cord pale brown; macro-

[11] Tijd. voor Entomol. 54 (1911) 46.

trichia of veins long and pale. Costal fringe long. Venation: Vein 2d A very strongly sinuous.

Abdominal tergites light brown; sternites similar, the margins of the segments restrictedly yellow; hypopygium yellow. Male hypopygium (Plate 3, fig. 40) with the outer dististyle, *od*, slightly dilated on inner margin at near midlength, the tip blackened and gently curved. Inner dististyle, *id*, shorter, more capitate at apex. Gonapophyses, *g*, appearing as simple, gently curved, blackened horns.

MINDANAO, Davao district, Calian, Mount Apo, Lino Lake, altitude 8,000 feet, September 19, 1930 (*Clagg*); holotype, male; allotype, female; paratypes, 5 of both sexes.

Erioptera (*Erioptera*) *alta* is most nearly allied to *E.* (*E.*) *lunicola* sp. nov., differing conspicuously in the structure of the male hypopygium.

ERIOPTERA (ERIOPTERA) LUNICOLA sp. nov. Plate 3, fig. 41.

General coloration testaceous yellow, including the pleura; knobs of halteres dark brown; legs yellow; wings tinged with pale yellow, with a small darkened cloud on anterior cord; male hypopygium with the outer dististyle a simple blackened paddle-like blade; inner dististyle with an acute spine on outer margin near base; gonapophyses blunt and irregularly toothed at tips.

Male.—Length, about 3.5 millimeters; wing, 4.

Rostrum pale; palpi darkened. Antennæ with the basal segments pale yellow, the flagellum brown; flagellar segments oval, with a dense white pubescence and slightly longer verticils. Head yellow.

Mesonotum almost uniformly testaceous-yellow, the lateral margins of the præscutum paler; pseudosutural foveæ and tuberculate pits more reddish. Pleura pale brownish yellow to testaceous-yellow. Halteres pale yellow, the knobs dark brown. Legs with the coxæ and trochanters yellow; remainder of legs yellow, only the terminal two tarsal segments infuscated. Wings with a pale yellow tinge, the base and costal region clearer yellow; a restricted dark cloud on anterior cord, this coloring involving the veins; veins pale yellow. Venation as in the subgenus; vein 2d A very strongly sinuate on nearly the distal half.

Abdomen pale brownish yellow. Male hypopygium (Plate 3, fig. 41) with the mesal-apical angle of basistyle, *b*, produced into a stout hairy lobe. Outer dististyle, *od*, a simple, flattened,

paddlelike, blackened blade. Inner dististyle, *id*, appearing as a flattened, mittenlike lobe, bearing an acute black spine on outer margin near base. Gonapophyses, *g*, blunt and weakly toothed at tips. Ædeagus paired.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, December 31, 1930 (*Clagg*); holotype, male; paratype, male; Mati, Mount Mayo, altitude 5,000 feet, January 30, 1931 (*Clagg*); paratype, male.

Erioptera (*Erioptera*) *lunicola* is readily told from allied species of the subgenus that have darkened knobs to the halteres and a faint darkened cloud on anterior cord of wings, by the structure of the male hypopygium. Among the regional species, the closest ally appears to be *E.* (*E.*) *alta* sp. nov.

Genus MOLOPHILUS Curtis

Molophilus CURTIS, British Entomology (1833) 444.

All of the known Philippine species of the genus, as indeed, all those known from the Palæarctic Region, belong to the so-called *gracilis* group, as defined by the present writer.[12] The correct definition of the many species can be made only on a critical study of the male hypopygium. The present key will suffice to separate the few species at present known from the Philippines, the characters used being those of the male sex only.

Key to the Philippine species of Molophilus Curtis.

1. Wings with vein 2d A long, ending opposite or beyond midlength of m-cu; wings with a darkened seam along vein Cu and less distinctly on the anterior and posterior cords. (Philippines.) *sirius* Alexander.
   Wings with vein 2d A short, ending before the level of m-cu; wings subhyaline or infumed, but uniform in color .... 2.
2. Antennæ (male) elongate, if bent backward extending to beyond midlength of abdomen; flagellar segments fusiform, with numerous very long erect setæ at near midlength .... 3.
   Antennæ (male) short, if bent backward not or scarcely attaining the wing root; flagellar segments suboval, with sparse scattered verticils and short, inconspicuous setæ .... 5.
3. Male hypopygium with inner dististyle a strongly curved black hook, provided with numerous short setæ on lower face, to produce a roughened appearance. (Mindanao.) .... *hispidulus* sp. nov.
   Male hypopygium with both dististyles slender and entirely smooth.... 4.

[12] Proc. Linn. Soc. New South Wales 54 (1929) 137–144, pl. 5.

4. Male hypopygium with the outer lobe of basistyle terminating in a gently curved elongate blade; inner dististyle about a fifth longer than the outer, heavily blackened on distal fourth. (Mindanao.) *procericornis* Alexander.
   Male hypopygium with the outer lobe of basistyle terminating in a circular flattened disk; inner dististyle about as long as the outer, not blackened. (Luzon.) .... *banahaoensis* Alexander.
5. General coloration of thoracic notum black, the scutellum reddish yellow; male hypopygium with the inner dististyle bearing an erect lateral spine beyond midlength. (Mindanao.)........ *remulsus* sp. nov.
   General coloration of notum brownish gray or grayish brown, the scutellum more testaceous; male hypopygium with the dististyle simple 6.
6. Wings with costal margin concolorous with remainder of disk or nearly so; legs chiefly dark brown, the posterior tibiæ light yellow, the tips narrowly darkened; male hypopygium with a small blackened hook on inner margin of outer lobe of basistyle. (Mindanao.) *mendicus* Alexander.
   Wings with the costal margin clear light yellow, contrasting with remainder of disk; legs brown; male hypopygium without a blackened hook on basistyle. (Luzon.).......... ... . *tawagensis* Alexander.

PHILIPPINE SPECIES OF THE GENUS MOLOPHILUS

Molophilus banahaoensis Alexander; ALEXANDER, Philippines, XI, Philip. Journ. Sci. 46 (1931) 289-290.
Molophilus hispidulus sp. nov.; this report.
Molophilus mendicus Alexander; this report.
Molophilus procericornis Alexander; ALEXANDER, Philippines, XI, Philip. Journ. Sci. 46 (1931) 290-292.
Molophilus remulsus sp. nov.; this report.
Molophilus sirius Alexander; this report.
Molophilus tawagensis Alexander; ALEXANDER, Philippines, XI, Philip. Journ. Sci. 46 (1931) 293-294.

MOLOPHILUS SIRIUS Alexander.

Molophilus sirius ALEXANDER, Canadian Ent. 47 (1915) 82-83.

Described from one male and one female, labelled only "Philippine Islands, July. F. Casey. Thru Miss Ludlow." No other specimens have been taken in the Islands.

MOLOPHILUS MENDICUS Alexander.

Molophilus mendicus ALEXANDER, Philip. Journ. Sci. 46 (1931) 292-293.

Described from the La Lun Mountains, Mindanao, taken July 3, 1930. An additional male, Davao district, Mati, Mount Mayo, altitude 5,000 feet, January 30, 1931 (*Clagg*), is much better preserved and supplementary notes are here given. The leg pattern is very distinctive.

Fore and middle legs black. Posterior legs with the femora black, only the bases a little paler; tibiæ abruptly light yellow, the tips narrowly darkened; tarsi black. The male hypopygium has the ædeagus long and slender, nearly twice as long as the longest dististyle.

MOLOPHILUS HISPIDULUS sp. nov. Plate 3, fig. 42.

Belongs to the *gracilis* group and subgroup; general coloration light brown, the dorsal thoracic pleura with a conspicuous, dark brown, longitudinal stripe; antennæ (male) elongate; wings with vein 2d A short; male hypopygium with the dorsal lobe of basistyle narrowed to a pale curved point; inner dististyle a blackened curved rod, the lower face with abundant coarse setæ.

Male.—Length, about 4 millimeters; wing, 4.5.

Female.—Length, about 4.5 millimeters; wing, 5.

Rostrum brown; palpi black. Antennæ (male) elongate, if bent backward extending about to one-third the length of abdomen; scape and pedicel light brown, the flagellum black, with the extreme tips of the individual segments a trifle paler; flagellar segments fusiform, the central portion of each provided with very long, conspicuous, erect setæ. Antennæ (female) short. Head yellowish brown.

Mesonotum light brown, the humeral region of præscutum yellow; pseudosutural foveæ darkened; scutellum testaceous; postnotal mediotergite darker brown. Pleura pale yellow, the dorsal pleurites occupied by a broad, dark brown, longitudinal stripe that becomes paler and more diffuse on the ventral pleurotergite. Halteres yellow, the knobs dark brown. Legs with the fore coxæ darkened, the remaining coxæ and all trochanters yellow; remainder of legs brownish yellow, the terminal tarsal segments darkened. Wings with a pale grayish tinge, the base and costal region more yellowish; veins pale brown. Venation: R_2 in approximate alignment with r-m; vein 2d A relatively short, ending just before level of m-cu.

Abdomen brown, the caudal margins of sternites a little paler; hypopygium brownish yellow. Male hypopygium (Plate 3, fig. 42) with the basistyle, *b*, terminating in three distinct lobes, the dorsolateral lobe, *db*, longest, relatively slender, densely setiferous on outer face, at apex narrowed into a pale, glabrous, curved hook; ventral lobe, *vb*, terminating in long retrorse setæ; mesal lobe smallest, pale, at apex with a group of about six

setæ. Two dististyles, the outer, *od*, a slender, sinuous rod, gradually narrowed to an acute point, the apical third blackened. Inner style, *id*, a powerful, blackened rod, arising from an expanded base, strongly curved at midlength, the lower or concave margin densely set with coarse setulæ from enlarged bases.

MINDANAO, Davao district, Mati, Mount Mayo, altitude 5,000 feet, January 28 to 30, 1931 (*Clagg*); holotype, male, allotype, female; paratypes, 1 male, 1 female.

Molophilus hispidulus is most nearly allied to *M. procericornis* Alexander (Mindanao), differing most decisively in the structure of the male hypopygium, notably the hispid inner dististyle.

MOLOPHILUS REMULSUS sp. nov. Plate 1, fig. 20; Plate 3, fig. 43.

Belongs to the *gracilis* group and subgroup; general coloration black, the scutellum reddish yellow; antennæ (male) short; wings strongly tinged with dusky; wings with vein 2d A short; male hypopygium with all lobes of basistyle short and obtuse at tips; two dististyles, the inner one more elongate, narrowed to an acute spinous point, beyond midlength bearing a small erect spine.

Male.—Length, about 3 to 3.8 millimeters; wing, 3.5 to 4.5. Rostrum and palpi black. Antennæ (male) short, if bent backward not or scarcely attaining the wing root, black throughout; flagellar segments subcylindrical, with coarse verticils that exceed the segments in length. Head black, sparsely pruinose, especially on anterior vertex.

Mesonotum black, the scutellum abruptly reddish yellow. Pleura black, pruinose. Halteres dusky, with golden setæ. Legs with the coxæ black; trochanters brownish black; femora obscure yellow basally, passing to brown on outer half; tibiæ brown to light brown, the tips darker; tarsi dark brown. Wings (Plate 1, fig. 20) with a strong dusky tinge, the base and prearcular region a trifle brighter; veins and macrotrichia darker brown. Venation: R_2 lying a little proximad of level of r-m; vein 2d A short, ending before level of m-cu.

Abdomen, including hypopygium, brownish black. Male hypopygium (Plate 3, fig. 43) with the basistyle, *b*, terminating in three broadly flattened lobes, the mesal one further produced into a small apical tubercle. Outer dististyle, *od*, shorter, a powerful arm that is extended at about a right angle into a more heavily sclerotized, flattened, beaklike portion. Inner

dististyle, *id*, more elongate, stoutest at base, gradually narrowed and curved to the acute tip; just beyond midlength on outer face with a powerful erect black spine; on outer margin, just before apex of style, with two or three microscopic appressed teeth.

MINDANAO, Davao district, Mati, Mount Mayo, altitude 5,000 feet, January 29, 1931 (*Clagg*); holotype, male; Calian, Mount Apo, Sibulan River, altitude 6,000 feet, August 29, 1930 (*Clagg*); paratype, male.

Molophilus remulsus is very different from all described Oriental species of the group in its black coloration, in conjunction with the structure of the male hypopygium.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b*, basistyle; *d*, dististyles; *db*, dorsal lobe of basistyle; *dd*, dorsal dististyle; *g*, gonapophysis; *id*, inner dististyle; *md*, middle or second dististyle; *od*, outer dististyle; *p*, phallosome; *s*, sternite; *t*, tergite; *vb*, ventral lobe of basistyle; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Pselliophora invenustipes* sp. nov., wing.
2. *Dolichopeza* (*Nesopeza*) *perdita* sp. nov., wing.
3. *Dolichopeza* (*Nesopeza*) *queribunda* sp. nov., wing.
4. *Limonia* (*Libnotes*) *tenuiclava* sp. nov., wing.
5. *Limonia* (*Limonia*) *patula* sp. nov., wing.
6. *Limonia* (*Limonia*) *desiderata* sp. nov., wing.
7. *Limonia* (*Dicranomyia*) *punctulatoides* sp. nov., wing.
8. *Limonia* (*Geranomyia*) *immobilis* sp. nov., wing.
9. *Atarba* (*Atarbodes*) *apoensis* sp. nov., wing.
10. *Eriocera* (*Eriocera*) *vittula* sp. nov., wing.
11. *Eriocera* (*Eriocera*) *vittipennis* Alexander, wing.
12. *Eriocera* (*Eriocera*) *dignitosa* sp. nov., wing.
13. *Eriocera* (*Eriocera*) *mindanaoensis* Alexander, wing.
14. *Gonomyia* (*Lipophleps*) *macilenta* sp. nov., wing.
15. *Gonomyia* (*Lipophleps*) *discreta* sp. nov., wing.
16. *Gonomyia* (*Lipophleps*) *tristigmata* sp. nov., wing.
17. *Gonomyia* (*Gonomyia*) *nebulicola* sp. nov., wing.
18. *Erioptera* (*Empeda*) *perrata* sp. nov., wing.
19. *Erioptera* (*Erioptera*) *alta* sp. nov., wing.
20. *Molophilus remulsus* sp. nov., wing.

PLATE 2

FIG. 21. *Dolichopeza* (*Nesopeza*) *perdita* sp. nov., male hypopygium details.
22. *Dolichopeza* (*Nesopeza*) *queribunda* sp. nov., male hypopygium details.
23. *Dolichopeza* (*Nesopeza*) *ludibunda* sp. nov., male hypopygium details.
24. *Dolichopeza* (*Nesopeza*) *evanida* sp. nov., male hypopygium details.
25. *Dolichopeza* (*Nesopeza*) *pudibunda* sp. nov., male hypopygium details.
26. *Limonia* (*Libnotes*) *tenuiclava* sp. nov., antenna, flagellar segments 1 to 4, 11, and 12.
27. *Limonia* (*Libnotes*) *tenuiclava* sp. nov., male hypopygium.
28. *Limonia* (*Limonia*) *patula* sp. nov., male hypopygium.
29. *Limonia* (*Dicranomyia*) *punctulatoides* sp. nov., male hypopygium.
30. *Limonia* (*Dicranomyia*) *moronis* sp. nov., male hypopygium.
31. *Limonia* (*Geranomyia*) *immobilis* sp. nov., male hypopygium.

PLATE 2

FIG. 32. *Atarba* (*Atarbodes*) *apoensis* sp. nov., male hypopygium.
33. *Gonomyia* (*Lipophleps*) *macilenta* sp. nov., male hypopygium.
34. *Gonomyia* (*Lipophleps*) *discreta* sp. nov., male hypopygium.
35. *Gonomyia* (*Lipophleps*) *tristigmata* sp. nov., male hypopygium.
36. *Gonomyia* (*Gonomyia*) *nebulicola* sp. nov., male hypopygium.
37. *Erioptera* (*Ilisia*) *fenestrata* (de Meijere), male hypopygium.
38. *Erioptera* (*Empeda*) *rata* sp. nov., male hypopygium.
39. *Erioptera* (*Empeda*) *perrata* sp. nov., male hypopygium.
40. *Erioptera* (*Erioptera*) *alta* sp. nov., male hypopygium.
41. *Erioptera* (*Erioptera*) *lunicola* sp. nov., male hypopygium.
42. *Molophilus hispidulus* sp. nov., male hypopygium.
43. *Molophilus remulsus* sp. nov., male hypopygium.

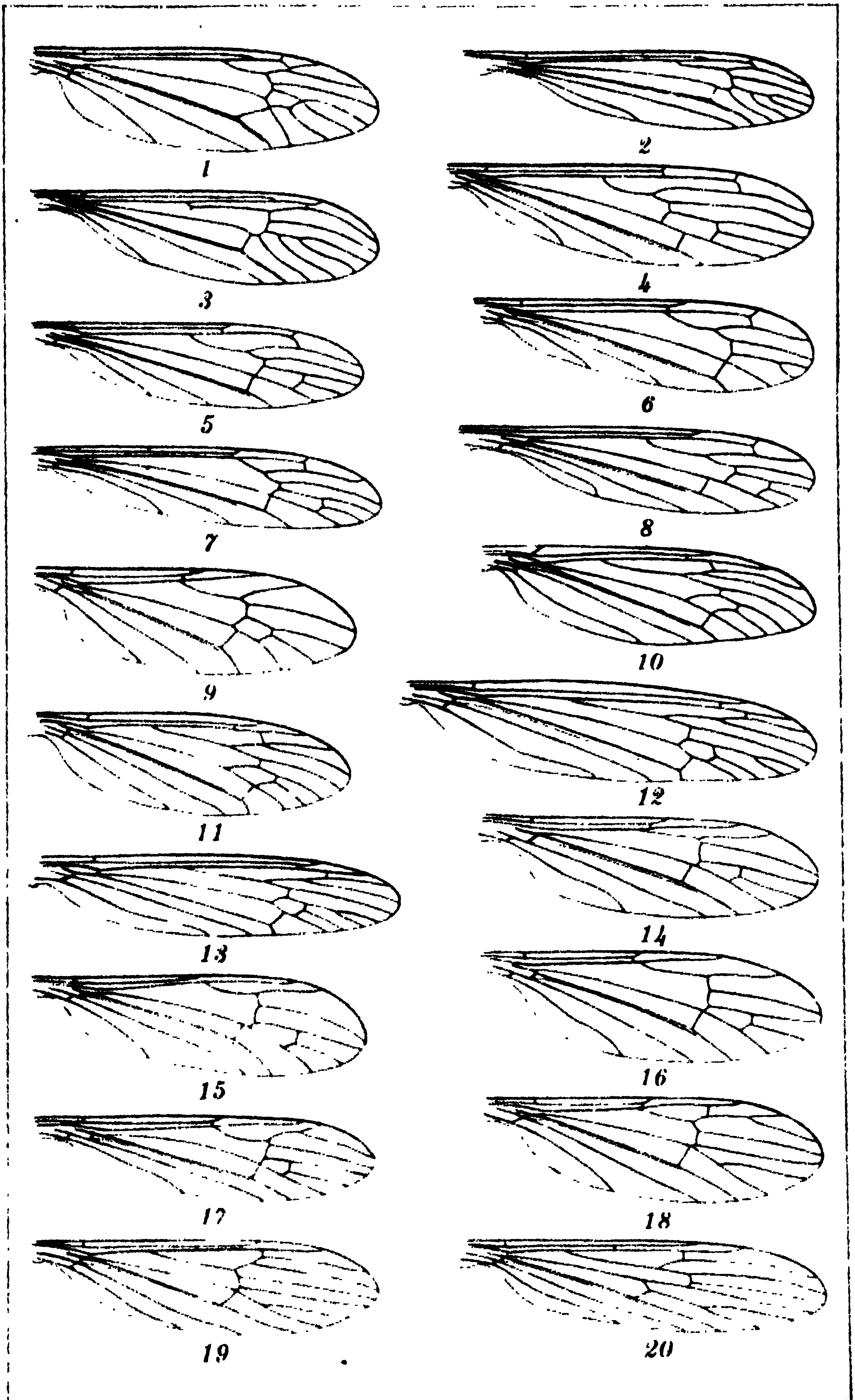
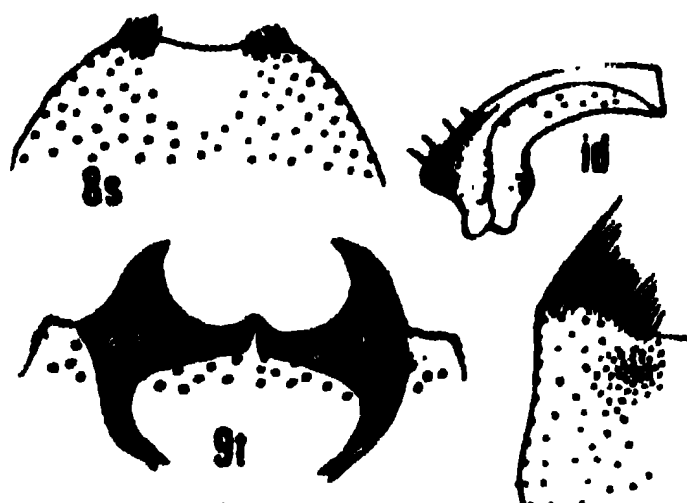


PLATE 1.



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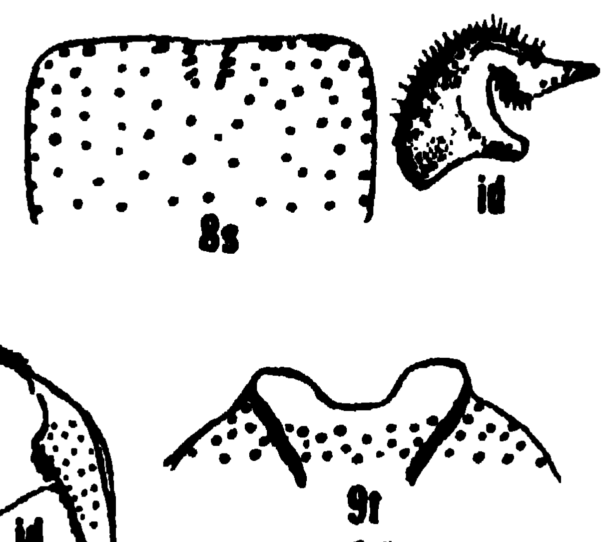

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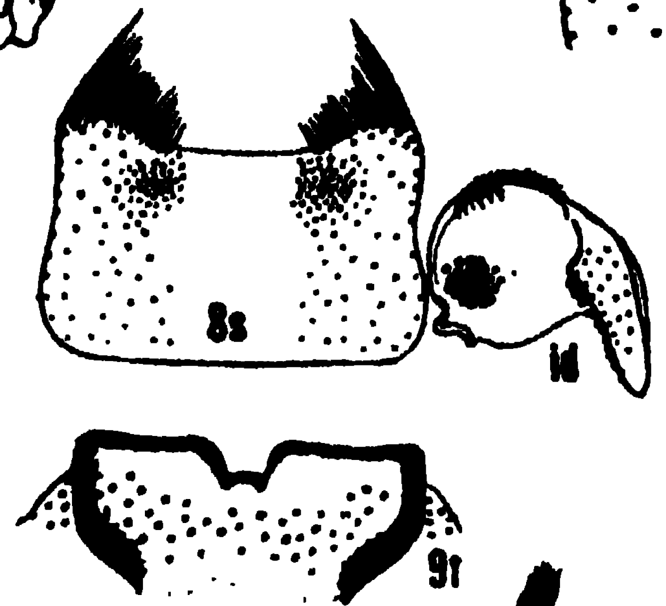

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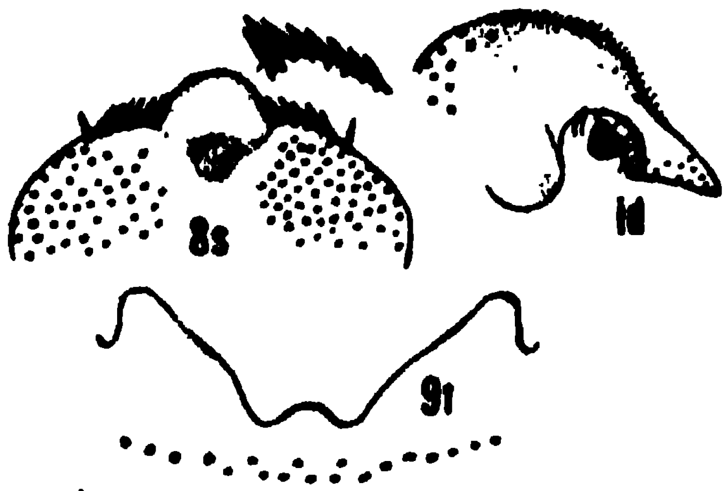

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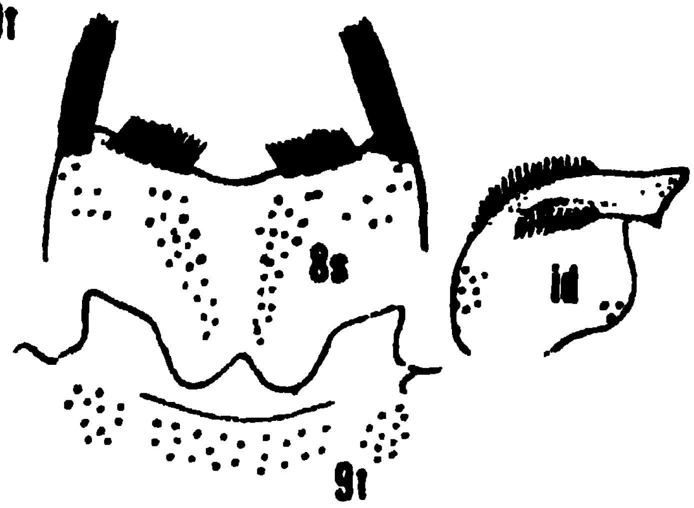

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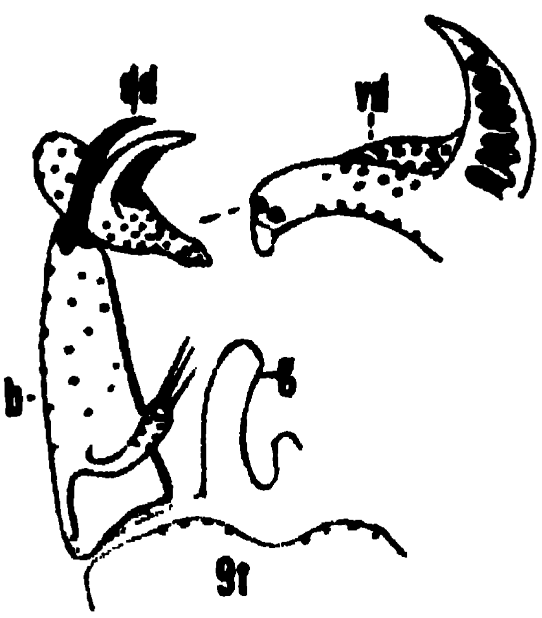

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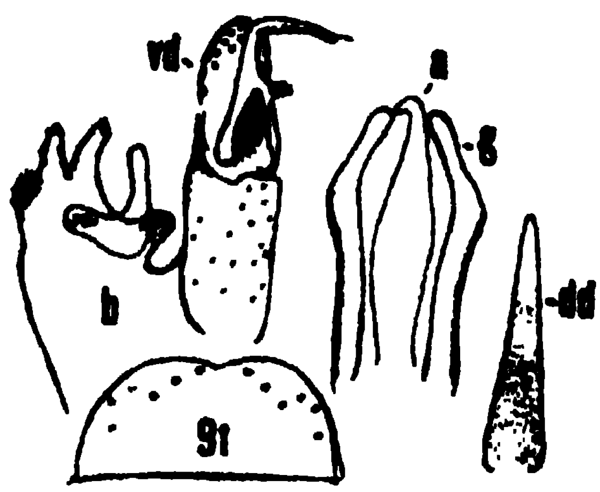

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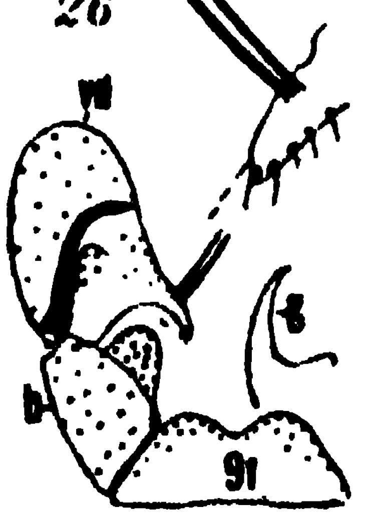

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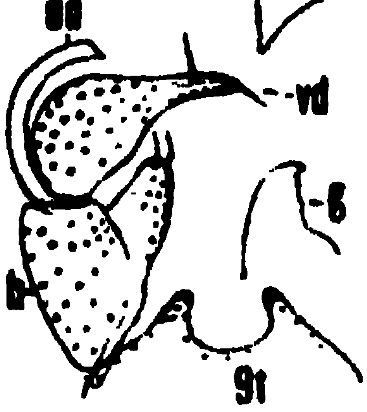

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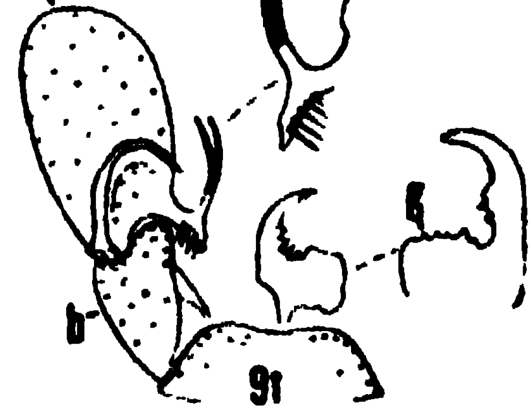

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PLATE 2.

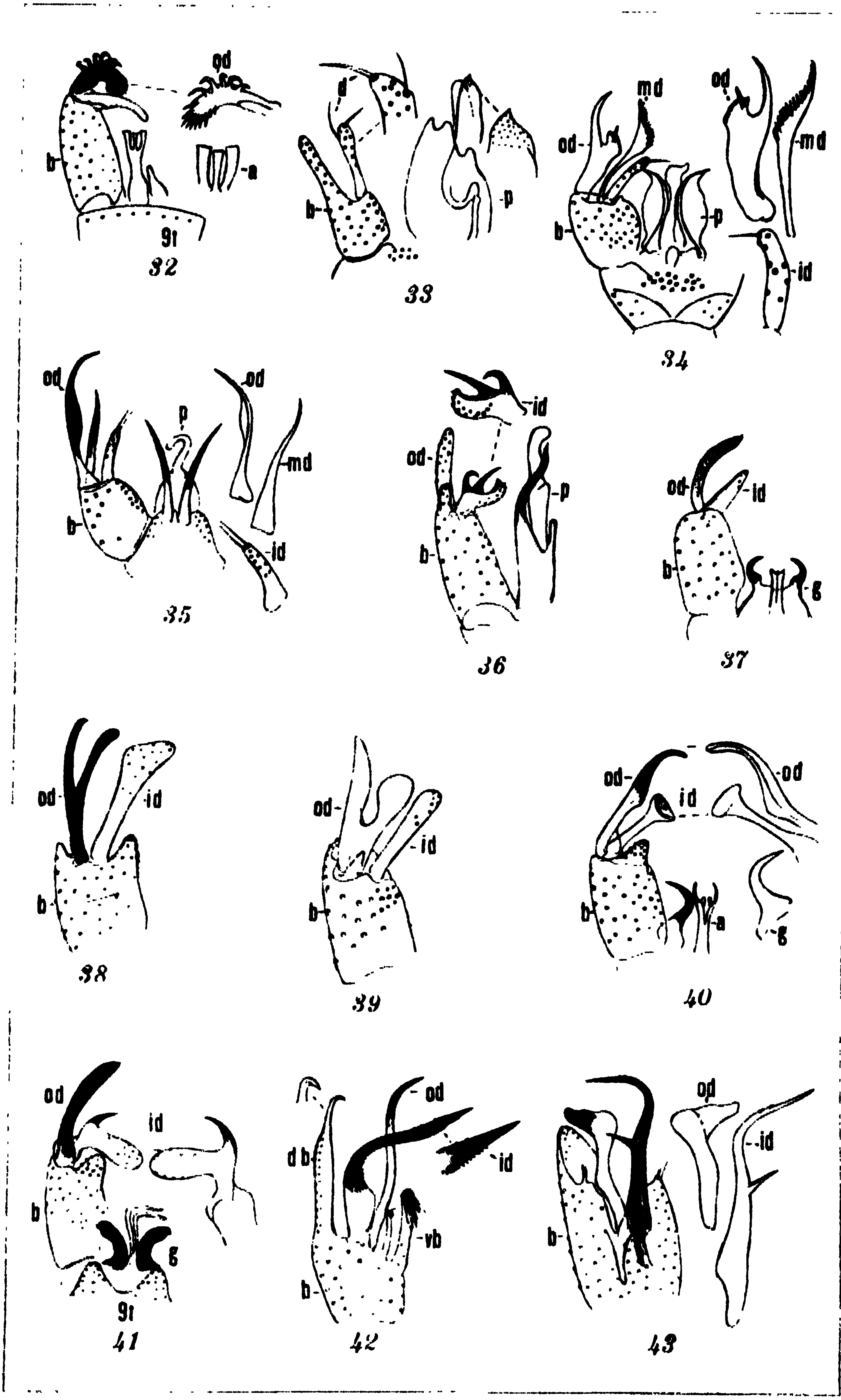
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PLATE 3.

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[New names and new combinations are printed in boldface.]

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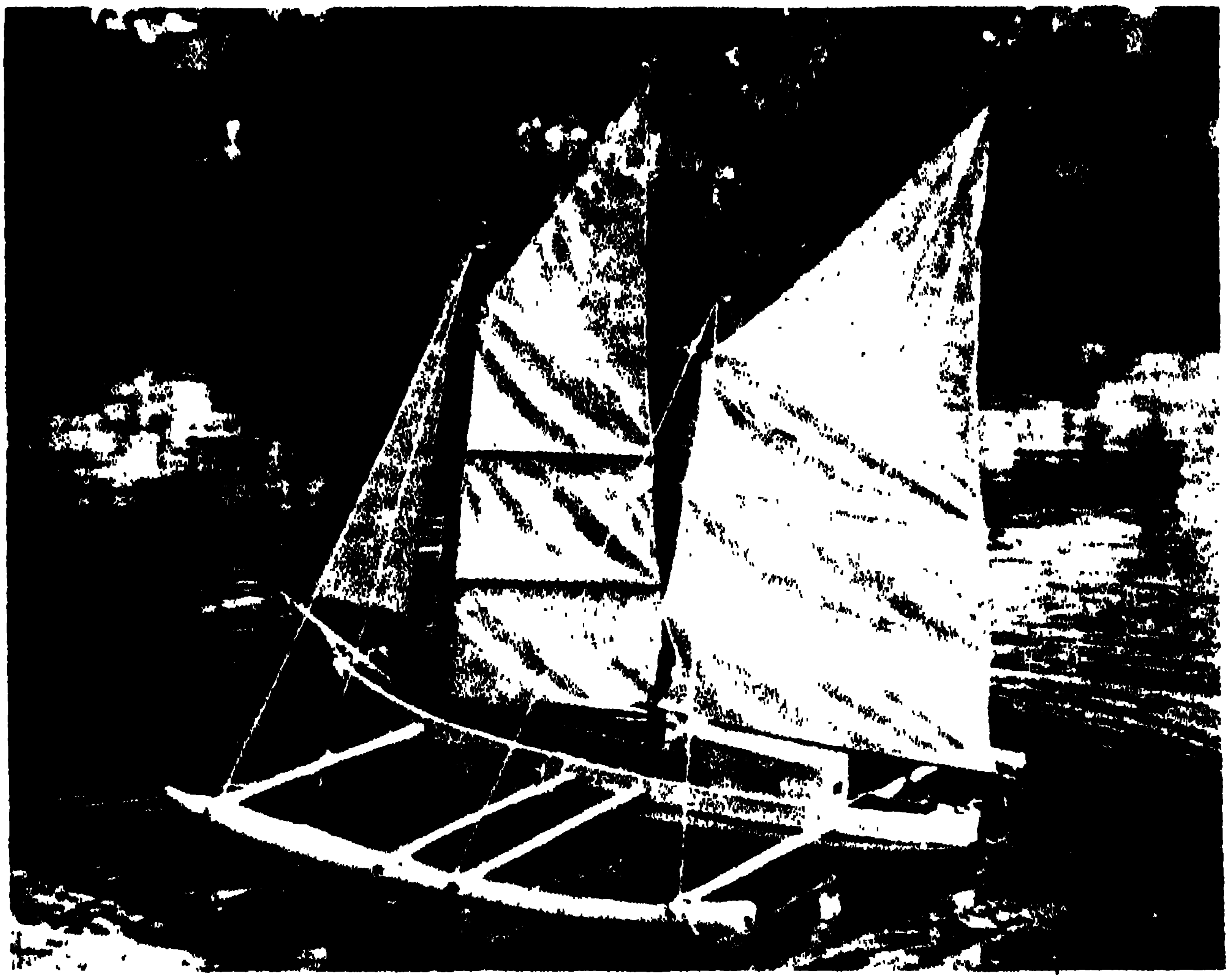

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PLATE 15.